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FAA R&D PROGRAM REVIEW, NAS PLAN, CAMI MISSION, AND PROGRAM PLAN

HEARINGS

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY HOUSE OF REPRESENTATIVES

ONE HUNDREDTH CONGRESS

SECOND SESSION

MAY 3, 4, 1988

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FAA R&D PROGRAM REVIEW, NAS PLAN, CAMI MISSION, AND PROGRAM PLAN

TUESDAY, MAY 3, 1988

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS,

Washington, DC.

The subcommittee met, pursuant to notice, at 2:15 p.m., in room 2325, Rayburn House Office Building, Hon. Dave McCurdy (chairman of the subcommittee) presiding.

Mr. MCCURDY. Today the Subcommittee turns its attention to the Federal Aviation Administration and its research and development programs.

FAA already has its FY 89 authorization from this Committee. So we want to take a broad look at FAA's R&D activities, to look less at specific budget line items and more at areas of influence and emphasis. We want to look between the lines, if you will, at what isn't there, what we may be neglecting.

We've scheduled two afternoons for this inquiry. This afternoon we'll hear from those outside the FAA, some of whom are R&D providers, all of whom are keen observers of the FAA. Tomorrow we'll hear from Administrator McArtor and other FAA officials.

One of the persistent themes of this Subcommittee, indeed, of the whole Committee on Science, Space, and Technology, is that we don't do enough R&D. That is surely true of FAA. But aside from doing more, we've also got to ensure that we do it efficiently, and that we research the right things.

The two very recent incidents with Aloha and United help to illustrate this point. Neither incident, as can be determined from preliminary press accounts, had anything to do with the air traffic control system.

If we are to be successful in avoiding these kinds of accidents, we must focus more of our research effort on aircraft structure and human factors. Those efforts have lagged in recent years as FAA R&D money has gone toward the NAS Plan, an effort of vital necessity, to be sure, but not an effort to replace work in other areas.

With all the talk about reorganizing FAA, I want to be sure we know what we're trying to accomplish. The way FAA plans for its future, does the necessary research, and then takes action will have a lot more effect, in the long run, than all the reorganizations.

Washington tends to translate concerns about safety into what it knows how to do best—reorganize. But, if FAA and its many over-

seers had spent the time planning for the fully predictable changes in aviation that we see in place today, almost any organization could have done the job.

We've asked our good and respected friend, Lynn Helms, to be with us today. We're glad to see you again, Mr. Helms, and we're anxious to hear your statement.

Later we'll hear from a distinguished panel of experts on FAA research: Mr. Jean Caffiaux from the Electronics Industries Association, Mr. Jack Fearnsides from the Mitre Corporation, Dr. Richard McFarland from Ohio University, and Ms. Edith Page of the Congressional Office of Technology Assessment.

We'll ask each of them to give us a 5 minute summary, and then we have some questions for the panel. At this point, I'm always pleased to recognize the distinguished gentleman from Florida, the ranking Republican member, Mr. Lewis.

Mr. LEWIS. Thank you, Mr. Chairman. Air safety, in terms of passenger miles, is at an all-time high. The number of people traveling by air is also at an all-time high.

At the same time, the anxiety level is on the increase. Passengers, while appreciative of the level of air safety, want the skies to be even safer. My own surveys indicate that they are willing to pay for the safety improvement by increases in air fares.

The news reports of the recent incident of the top of a 737 blowing off in Hawaii brings a feeling of relief that the loss of life and limb was so small. On further reflection, I wonder if this accident could have been prevented. Is it possible to focus a long-range research program on predicting such catastrophes before they occur? Should FAA undertake such a research program?

I hope today's witnesses can give us some guidance in these and other areas. For example, how can FAA research programs be made more effective? What long-range research programs should FAA have underway that would help improve air safety?

I look forward to hearing responses to these questions by the experts testifying, and, also, Mr. Chairman, I would like to welcome Mr. Helms and his great counsel in these areas. Thank you, Mr. Chairman.

Mr. MCCURDY. Thank you, Tom, and we share your concern. One thing, Lynn, you can tell in this Subcommittee is that we have a strong bipartisan consensus on almost all of these issues. We have a very good working relationship, and this is one area that we would like to pursue in detail.

And we certainly welcome your knowledge and expertise and experience in this area. Your full testimony and statement will be admitted into the record in its entirety, and you may proceed as you wish.

STATEMENT OF J. LYNN HELMS, FORMER ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION

Mr. HELMS. Thank you, Mr. Chairman and Mr. Lewis. With the Chairman's concurrence, I would like to have the full statement inserted in the record. However, in the interest of brevity, I will summarize that, and do so in slightly different context from the written statement.

Specifically, I'm talking about three areas. That is, some background items which I feel are significant to members of the Committee, only because there needs to be some form of institutional history starting to be established as to why certain decisions were made and the accountability of those.

I'll spend only a small amount of time on that, the present status of the R&D program, where I see it, and what I think some of the factors are that affected it. But I want to spend most of my time on outlining a new program or a new core concept of where we ought to go from here, in the long-term, particularly.

Much has been said about the NAS Plan, as it properly should have been. However, I think, to put it in its proper perspective, we can say that the intent was to create a plan that met the economic needs of the nation past the end of this century. One that provides a safe and efficient use of necessary resources to respond to public needs.

That plan, then, as one of five, was one which I began to initiate when I first came in as Administrator. During that time period it became evident to me that we had what became widely known through the Agency as "two and a half" engineering departments. That was my description of it.

We had an advanced design engineering group that prepared the systems engineering, the analysis, and specifications. These were handed off to procurement.

We had a separate technical function within the then air traffic function that got these specifications and equipment and then examined it to see if it met their needs, and modified it with ECPs and costs and schedules. And then they handed it off to the technical center for tests.

That's what I referred to as the half, if you will, because there was another half element which was reflective of the regions there, and it was redone again.

With the NAS Plan, then, of such magnitude, approaching the size of Apollo in its gross aspects, it was obvious this had to be changed. There had to be single-point authority, a single point of responsibility, and single-point accountability with the ongoing mainstream effort, and, secondly, to ensure that the R&D effort was blended in.

Therefore, during the first year we created a single-point authority organization with responsibility, authority, and accountability for the totality of the systems engineering and of the research function.

Also during that time period, CAMI, and, to a lesser extent, the Technical Center were funded in their research efforts by other segments of the FAA. Hence, to some extent they became, I'll say, a prisoner of those other elements that had money. And what we wanted to do was get them around the NAS Plan and around their specialty functions, and have them funded independently.

I'll just use one example in each case to make the point. In the area of the Technical Center, there's probably no place in the world that knows as much about how to predict, control, and look at inside-the-cabin fires as there. Therefore, that research should be funded independent of the NAS Plan and have no direct connection. But it needed to be done on an ongoing basis.

In the case of CAMI, there's probably no place in the world that knows as much in the area of the human physiology of being able to get in and get out of an aircraft in emergencies. While the NAS Plan had nothing to do with it directly, it had to be supported, because the more traffic goes up as a result of the NAS Plan, the more we needed to know it.

So, there were specific areas of research that would fall out separately. To accomplish this, then, a single point function was established, and all elements then reported in to the Associate Administrator of the new function.

I decided also, during that time period, that one other thing had to be done. We established a separate test and evaluation function at the Tech Center, reporting directly to the Deputy Administrator. I did this on purpose.

One reason was that I wanted to have a completely separate function, something that was completely independent of the technical organization that was testing that final hardware and/or software and/or procedures, and advising the Administrator's office whether in fact we were achieving what we had bought. Did the equipment work to the specification level? Were we able to operate it? Did we understand it well enough?

And, secondly, the reason I wanted it to report to the Deputy Administrator was that I was running the day-to-day system design. I did not think it was proper for it to report directly to me, so that I became the evaluator of my own design effort. Hence, I had it report directly to the Deputy Administrator. Again, I met every morning to discuss the results of the tests and other items.

As far as background, there are only two other items that I should mention. One is that the Federal Government planning and procurement process is built around a 10 year cycle. This is reflected in President Kennedy's statement that, "in the next decade we will place a man on the moon."

The only reason I mention that, Mr. Chairman, is that there has been much discussion about the NAS Plan that refers to it as the 10 year plan, or the $10 billion program. Even though we have repeatedly gone on record acknowledging it, I want to again point out that the NAS Plan was intended to cover over 15 years, and the terminal point was designed to be compatible with the ICAO date of 1995 for introducing MLS and some other items. So, it was not just a 10 year plan.

Secondly, it has been referred to as the $10 billion program. But I personally briefed members of Congress and I personally briefed the Administration, to the highest levels within the Administration, noting that the cost in 1981 constant-year dollars was estimated to be $14.7 billion.

Turning to the situation as it exists today, in my view, probably the most generous statement I could make is that the FAA R&D program is neither meeting the original plans nor the need of the national public. I am quite concerned that today the program is not only not fulfilling the original intent, but the major portion of the funding sources are being used to keep the NAS Plan on schedule, and in fact to fill in some of the gaps that have come about. This just was plain not the intent when we presented the program to Congress.

The defined subsystems of the NAS Plan are quite capable of meeting their original design objectives, but not the original dates, I acknowledge. However, those of us that live in the business of managing technology to enhance man's livelihood know that that's just not enough. They can get more, and they can get better.

Again, in the interests of time, I'll just use three examples, without going through all the details, because it would take a volume unto itself. Those that were involved with me daily will remember that the NAS Plan had to start with solving the collision avoidance problem. Just briefly, you had to make the decision, is it going to be solely airborne, or is it going to be dependent upon the ground. And out of that started to unfold and shape the NAS Plan.

The traffic alert and collision and avoidance system, or TCAS, was one of the first decisions that came out, and it's gone along. Too slow, but it's well underway. But the Congress has wisely, now, mandated it.

But I am concerned that we have not taken adequate benefit of what else can be done. Additional research should have been added to it, rather than subtracted from it.

For example, we now hear about, "the crowded skies, the overworked controllers," the fact that there are too many airplanes there. Once we bring the airplanes in over final approach through a coded exchange, the pilot now station keeps. By using TCAS, he literally watches the airplane ahead of him and maintains his own 2 mile separation or whatever it is that's decided for that particular airfield. He does that all the way around the traffic pattern, but with the full knowledge that the ground controller is watching him 100 percent of the time, monitoring what he's doing, so that, if he gets off, he will get an immediate correction.

Think of the vast number of reductions in transmissions that go back and forth. And since 80 percent of the so-called system errors are traceable back to lack of effective communication—somebody used the wrong phrase, the wrong serial number, somebody for whom English is a foreign language, a student—if we could eliminate more of those transmissions, we could eliminate a lot more errors.

To go a step further, today, since we do not have radar coverage over the north Atlantic, we have to maintain 2,000 foot altitude separation to ensure positive separation. With TCAS we could go to a thousand, and do it very easily, because every aircraft could see every other.

In fact, we could take the 6 tracks across the north Atlantic, make 3 of them for TCAS only, and for those that didn't want to buy it, let them go in the other 3. Fuel savings on the north Atlantic alone, if you could select your altitude within a thousand feet instead of 2,000, is over $100 million a year.

So, we're talking in terms of very practical potential, and this potential is not being satisfactorily examined because of lack of research and development funding.

I will use another example, but not take as much time, and that's in the area of the digital data link. This offers us more possibilities for the future than perhaps in any other item, as far as benefitting the air traffic control system. Literally, with the data link, we should be looking at the possibilities of a pilot now taking

off from Los Angeles for New York and at any point throughout that flight path being able to tap in with his coded signals and get the latest weather at JFK, only three minutes old.

In fact, if he's concerned about the line of thunderstorms, patch in through the data link and let him see on his CRT the actual radar display of the line of thunderstorms that the controller is looking at. This is very practical, Mr. Chairman, but we are not conducting research in that area.

I'll use just one more example on that. In 1982, in an attempt to find out how valuable a data link would be, so that it could be placed within its proper priority within the NAS Plan, I had a study done of what the average number of transmissions a flight deck crew made from leaving Los Angeles to JFK. This depends, of course, on your route, the time of day or night, et cetera. But the average came out to be 31. Thirty-one different frequency changes, and new contacts had to be made.

With data link, it is potentially possible to have 2, the initial call up for clearance and the call up to the tower to land. And everything else could be done by Data Link. Think of the improvement, then, in the validity and the integrity of the data exchanged. A gross reduction of the pressure on the air traffic controller. Data link should be now being looked at exhaustively.

However, I would like to move to what I believe is the real purpose of this hearing, and to me is the most important. That is, where should we go in the future.

The memory capacity, speed, software, and the data telecommunications capability now convinces me that, just as the NAS Plan served to be the catalyst for farming out all new areas of research and development in new fields, we should now undertake a dynamic simulation effort.

We can now, through the use of computers, simulate the entire New York control area, putting in all of the air routes, the locations of the equipment, the altitudes, and simulate this, and let that simulation show on the scopes, the aircraft flying back and forth.

Then we should move that equipment to new locations and see what did that do to the air route structure. Did it improve it?

Then, we should change the specifications for it, and say, what if we specified different equipment. And we start to build in a capability, then, to dynamically simulate all of the new equipment that will flow out over the next decade and the next 25 years, so we don't face the situation of having to start all over again, like we did this time.

We could then start to put in helicopters, so that we now can monitor the effect of helicopters through all of the 5 airports and the reliever airports, even the float planes on the East River.

We could then go a step further and say, now, in 1995, we know the tilt-rotor vehicles are going to be here, and with the capability to cruise over 300 miles an hour for the first time. Why not simulate that and take a look at using some of the two and a half miles on the east side of the Hudson River?

We can give up 2,000 feet. Two thousand feet would handle 15 airplanes on the ground at one time of that type. So that, is it possible to have now valid town center landing in New York? And

with the microwave-system-served approaches, now we have the precision capability that we didn't have before.

We are now underway and examining the possibility of the aerospace plane, the so-called Orient Express. Shouldn't we be looking at how we're going to get it on and off the ground and in the air traffic control system? The dynamic simulation model would let us do that.

Then we should go to the next step. Once we have the model working, we should create a mini-approach control for New York, and bring in actual flight controllers and let them sit there and run this system and tell us what's wrong with it. Tell us, then, how changing this equipment works.

And go a step further and crank in bad weather. Let's see the effects of bad weather on it. Let's take the consideration to where we have an aircraft in flight, and it has a completely unexpected emergency, similar to the two that you have mentioned. That is, maybe some in-flight explosion. By using the dynamic simulation model, we could examine the quickest and easiest way to get that airplane on the ground from anywhere in the area, and develop procedures for it.

The fact that we had 3 engines of a 747 go out before that airplane got off the runway. Unbelievable, mathematically. But at the same time, wouldn't it be great if we could simulate these types of things and see?

Then we should go a step further. With today's telecommunications capability, after we have that system working, we should connect in the flight deck simulators: Eastern Air Lines in Miami, American in Dallas, United in Denver, USAir in Pittsburgh. And now let the flight deck crews themselves become part of this dynamic simulation so that it is a completely interactive element. Since they have to do it every few months anyway for their update and flight refresher, why not have the pilots' input and the flight deck's input into this feature.

Finally, we should do one other thing. Even though this is not part of the aviation segment, I still feel our responsibility is to move people efficiently and safely.

We should crank into this dynamic simulation model the capability of the high-speed train. The French are now running their train at 160 miles an hour. The Japanese have exceeded 300 miles an hour with theirs. They routinely do 225 to 250 miles an hour.

Dare we sit here and not look far enough ahead in research and development to do some form of dynamic simulation and trade-off for the American people between building a series of $3 to $5 billion airports as opposed to maybe $3 to $5 billion dollars for a high-speed train? The dynamic simulation model would allow us to do that.

Mr. McCURDY. I was teasing Tom. I said you just rang his bell, because if there's an advocate for a high-speed train anywhere in the United States Congress, it's sitting right here.

You were well prepared. You talked about CAMI in the first segment, and you hit the high-speed train here.

Mr. HELMS. That was not done on purpose, because I didn't know Mr. Lewis had that degree of love for it. But I do feel this way.

Good research will tell us what the future is, and a good examination of the future will tell us what our research ought to be. What I want to do is to take a longer-term look at it, and let this become the core program, then, from which the research program for the FAA can now start to spin off, so we can now start to look 15 to 25 years ahead of time, and place them in relative priority. That to me is the advantage of it.

And the NAS Plan created that core, the first 5 to 10 years, and showed where we wanted to go. But we had to do that for modernization. I believe the dynamic simulation model could do this, and fulfill the responsibilities that we have to continue to generate the economic strength of the country.

I'm sorry that it took this long for my oral statement, but I felt I had to talk a little bit about this one, Mr. Chairman, because I feel, after my analysis for a year and a half, it's the only program that I can see that's going to give us a long-range view of where the R&D ought to go.

I thank you, Mr. Chairman.

[The prepared statement of Mr. Helms follows:]

May 3, 1988

Testimony of

J. LYNN HELMS

to the

Sub-Committee on Transportation, Aviation, and Materials

of the **Committee on Science, Space, and Technology**

U.S. House of Representatives

Mr. Chairman, and distinguished members of this Sub-Committee, I am particularly pleased to attend this hearing, as the subject of the Research and Development program of the Federal Aviation Administration is of vital interest to me, but more importantly to the nations public. I would like to approach it by discussing three separate areas:

(1) Background items of significance to the subject; an effort to establish for the Sub-Committee some slight instituitional record of decisions made and reasons thereto during a finite time period.
(2) The present status of the RD program; and some of the reasons for the opinion expressed.
(3) Some thoughts on where it should go; with particular interest on the long range program.

(1) Background items

Much has been said, and written, about the National Airspace Systems Plan, (NAS Plan) as properly should be. Equally, much which was an original part, and some changes affecting the original plan, has, even though publicly been stated, generally been ignored, or at least given far less public dispersal.

Shortly after Pres. Reagan was elected in November of 1980, I was contacted by both Members of Congress and industry to outline a strategic plan for the future civil aviation program of the nation, primarily built around the Federal Aviation Administration.

Working from November 1980 through January of 1981 this plan was completed, (well before I had even been approached to become Administrator), and based on using a Systems Engineering approach to a redesign and modernization of the systems used to control the nations air traffic. The objective was really quite simple: "Create a plan that met the economic needs of the nation past the end of this century that provides the safe and efficient use of necessary resources to respond to public need". That portion, one of five separate strategic plans, contained the what and why of the NAS Plan.

After only a few weeks as Administrator, while laying the groundwork for inititating the NAS Plan, it became evident to me that the organization had what I frequently referred to as "two and a half engineering departments". Admittedly I am over-simplifing, but the agency had and Advanced Engineering Development organization, that conducted engineering studies and established specifications for new equipment and handed them off to the Purchasing function to procure. Separately, within the then Air Traffic support function, another engineering group would receive the equipment, consider why it had to be modified to meet their needs, and then issue such change directives as they felt necessary. Obviously, this increased cost and caused delays. A separate group yet, the "half" that I referred to earlier, would get initial issues of the equipment and test it at the Technical Center in Atlantic City, with additional changes stated as "necessary" by the various regions whose representatives reviewed the equipment and tests. Equally, the Research and Development functions of CAMI (Civil Air Medical Institute) in Oklahoma City and that of the Technical Center had separate reporting channels, and were to a great extent pursuing the research their own center directors approved. I must acknowledge their truly was an element of coordination at the level of Associate Administrator for Advanced Engineering Development. This situation HAD to be corrected, to both establish direct control over all engineering design and development functions, to insure no party could later say he had to have changes because he was not part of the decision making process, to bring about a formalized and long range objective orientation for RD as a total function of the FAA, and perhaps most of all, a true Systems Engineering approach to the NAS Plan could only be successful with single point authority, responsibility and accountability for all.

For these, and other less important reasons, a new SINGLE AUTHORITY organization was constructed to integrate all the prior elements of an engineering or research function. Further, the "user" functions had to "sign off" on the final specification (this encouraged them to dig in deep and actively participate in the establishment of such specifications). Further yet, a completely separate Test and Evaluation (TE) function was established at the Technical Center in Atlantic City, reporting DIRECTLY to the Deputy Administrator, to advise that the confirmation tests were conducted

properly and the results were accurately reported against specification. (I elected to do this on purpose: since I personally was directing the day by day system design, and residual development program of the NAS Plan, I wanted to have a separate group evaluating the result. I elected to have them report directly to the Deputy Administrator so that he could tell me we either were or were not achieving what I had originated; I did not want to be my own system designer and system test evaluator). That group also signed off on the specification, so they could start their test observation and confirmation planning process far in advance of actual testing. Finally, as an integral part, the new function was tasked to now come up with a longer range RD plan, to consider areas OTHER THAN those required to meet the component, sub-system or system requirements of the on-coming NAS Plan. Only a single point location could clearly establish such an interface, and be held accountable for performance in both areas without overlap.

One other Two-part item should again be noted publicly, as it has been before. First, the Federal Government planning process is based on ten year projections as the considered time period. Even Pres. Kennedy noted in his procolomation for the Apollo program, "in the next decade", we will put a man on the moon. The NAS Plan, second only to Apollo in the combination of technology, size, time, schedule, new sub-systems developments, requirements etc, was also required to conform to that practice. Hence, while public reports have referred to the "ten year program", or the "10 Billion dollar program" of the NAS plan, the original plan, as contemplated, presented to the Administration, and personally discussed by me with members of Congress was based on a fourteen year plan, (geared to end with the requirement of certain ICOA requirements by 1996) and projected to cost 14.7 billion, in 1981 constant dollars. The 10 Billion dollars (various rather close numbers have been used) referred to the ten year planning requirment.

Second, the NAS Plan was never conceived, designed or presented as a "end all/cure all" program. Those of us as responsible spokesman never presented it as such. It specifically noted the recognition that no knowledgeable group would commit themselves to a program ending some fourteen years hence, and IGNORE the benefits of new technology! It was, is, and I hope shall remain, a program to NOT start over from scratch again as we have done twice in the nations history. Rather, it was intended to lay out a specific design, with sub-system requirements, to meet our immediate needs; recognition of how new technology with further enhancements could and would be phased in over the next quarter to one third century; and establish an RD program to accomplish such new and then un-predictable enhancements and advantages. This would allow us, as long as we kept emphasis on the total System as an engineering criteria, to continually and successfully guide our RD program, introduce new components, sub-systems, operating procedures, design specifications etc. into the overall system reflecting the newest technology both proven and available and do

so while taking into account the technology advancements in the air vehicle side of the system. The Air Traffic Control system should never be used to "PROVE" new technology.

In summary, none of the foregoing is meant to convey that either plans or programs should not be modified or changed as good sound technology, or other reasoning comes forth. (In fact, they should be changed when occassion requires) Equally, unless such reasoning is unmistakably established, there is no substitute in the technical field for single point authority, responsibility and accountability for insuring Research and Development is so closely related to on-going developments, that it truly "extends the potential" of the designated technical developments and responsibilities then existing. I do NOT refer to Basic Research.

(2) The Present status

The most generous statement I could make is that the FAA RD program today is neither meeting the original plans or the national need. I am quite concerned that today the RD program is not fullfilling our original intent and committment, but rather is being used to fill the gap between the original NAS Plan and what is necessary to keep that Plan as close to schedule as possible. This was certainly never intended, not even envisioned at the time of presenting the NAS Plan to the Congress. Other observers may say "Mr. Helms just isnt that close to it anymore, and doesnt know the intimate details". He (or she) would be right. Equally I might say "I can look at the funding profiles, talk to the people doing the research, examine their accomplishments and say without reservation the needed and planned RD program has been very near emasculated." I would be right!!

The defined sub-systems of the NAS Plan are quite capable of meeting their original design objectives, albeit at later dates than intended. But those of us who live our lives in the field of conceiving and managing the use of technology to enhance mans livelihood know that is not enough. The public that paid for it not only deserve more, they can get more! Good RD makes more, far more of initial developments. Yes, it costs money; but tell us one physical thing that is particularly desirable that didnt! Consider, how would Henry Ford look at todays front wheel drive LeBaron, the plastic body Corvette, or his own Companys Motor Trend car of the year, the aerodynamically designed Taurus and remotely consider they came about other than through RD to support original concept, or design.

Let me take just a couple of examples; (there are many!) to show what should have been done before, but absolutely must be done now, with a new level of energy. It will sound odd to most, and many will question the validity, but those involved in the daily design sessions with me understand why that in initiating the detail design of the NAS Plan configuration it was apparent I had to first decide the approach to collision avoidance, because of the potential impact on the rest of the system. Hence, I made the

decision on a configuration, called TCAS. (Traffic Collision and Avoidance System) The decision logic and reasoning is quite lengthy, and I will elaborate if requested, but for now consider a decision was made to finally stop "studying", select a technical approach and get on with it. I caution that throughout my testimony certain of the statements are over-simplified, because each sub-system and the integration are so complex as to require volumes, but equally each statement is also factual. The TCAS System design was initiated, test models constructed, operational tests conducted etc etc. Today, prototype systems are going into airliners for operational evaluation, and Congress has rightfully mandated such devices for the future.

But that isnt enough. There is no question TCAS is intended to improve aviation safety; that it will do so, and that program is now real. Further, their is an element of "product" research continuing in support of the development, even though not enough. But consider, once it is in service, can it perform no other service or function? Does it have application in other areas, even while performing its primary function of air safety? Most assuredly, and we should have been heavily investing in such research for the years subsequent to final system definition. The public is constantly reminded of "close calls", or "near miss", or "system error" and most common, "the crowded skies". In fact, the skies are not crowded at all; in their entirety they are actually lonely!!

The problem, recognized by all the professionals, is that certain segments of airspace in a very few geographic areas has a high concentration of air traffic. But what about both the rest of the airspace, and what TCAS just MIGHT be able to do to more effectively use both the near empty and that concentrated usage airspace? Practically all passenger carrying flights follow published airways, an "electronic path in the sky", and do so under IFR (Instrument Flight Rules, which means detailed control of the flight path) conditions. That means the rest of the vast cubic volume of airspace over this nation is essentially empty! -possibly used by the military, who are also under postive control at the altitudes of airliner concern. It becomes apparent -easily ten to twenty times, -probably more by far, the volume of "airways" airspace can be used if positive "control" is assured. The problem is that the air traffic controller must have some form of "procedure", or "organized system" to get traffic into a path which allows him to CONSTANTLY monitor all, and insure separation.

Consider; TCAS now gives an on-board BACK-UP to the flight deck crew to insure they are safely separated, hence, as a function of air traffic density by altitude, flights could be cleared "point A to point B direct", saving time, fuel and relieving the density of the airways, IF the aircraft has an adequate TCAS system installed. Yes, we do it some today, but to only a small portion of the volume of airspace available. TCAS would give an AIRBORNE back-up independent of the controller, and independent of the expanded conflict alert system now coming on stream. (Because we

have new computers coming on stream that can handle them, part of the planned NAS Plan) Consider; since radar coverage cannot cover flights between the U.S. and Europe over the North Atlantic due to distances, altitude flight separations of 2000 ft are required to be absolutely certain of separation. With TCAS each aircraft could see the other, hence reduce the separation to the normal 1000 ft normally used. Results; far more flexibility to "fly the weather" profile, for smoother, easier and faster flights, AND, a savings in fuel cost of over one hundred million dollars a year, just on the North Atlantic alone. And TCAS could do the same thing all around the world.

In the "concentrated activity" locations, the controller must not just "see" separation on the radar scope, but he must also be in constant radio contact to give directions to insure safe separation, to every airplane under his control, (and from some NOT under his control, if he can "see" them on the radar). In the terminal phase, this requires many exchanges, regarding heading etc. Consider; once the controller has the aircraft in the final pattern for the airfield, could the flight deck crew themselves "station keep", i.e. maintain their designated separation by watching their TCAS presentations on the video screen, thus constantly watching the aircraft ahead which he is following, but with absolute and constant back-up monitoring by the air traffic controller. This could grossly diminish the number of exchanges between the controller and the pilot, allowing each more time to review their "environment" and providing time to consider all elements. How will we know if we do not formally and actively conduct research to verify the potential penalty or results. Paper consideration is not enough.

TCAS has MANY more such possible applications, and when combined with Satellite Navigtation offers vastly more efficient, and safe, over-water and International flight possibilities. Such considerations should have been heavily underway as research programs for the past three or four years.

With less detail, I will treat the second of the two. In the inital system design trade-offs and configuration definition it became apparent that a digital data link would have to occur, because of the increased validity of the exchange between the pilot and controller, because of the far far more information that could be made available to the flight deck crew, and to further decrease the workload on the controller, giving him more time to appraise and mentally integrate the events before him, and reducing the time he must be in direct voice communication. Notice, I said "reducing", and in no way implied eliminating or curtailing. The "Mode S data link" was identified and established as part of the original NAS Plan, and the hardware is now in the procurement cycle. But, research on expanded uses, methods to use technical capabilities to enhance safety through secondary benefits, and other elements are not being adequately pursued, for lack of funding. The potential is so great that even people who have spent

their lives in aviation have difficulty absorbing it all. Consider; while inflight, real time readout of weather conditions for any place in the U.S., and such information (if AWOS is installed at the location) no more than 6 minutes old. Consider; while inflight anywhere in the U.S. and for any destination, with proper equipment aboard being able to call up and have THE PILOT SEE PERSONALY the ACTUAL weather radar information for a given area, even as it is being received by the local ground station, more than a thousand miles away. Far far more can be done, without any doubt, and I urge the committee to demand further committment to realize those potentials.

If we have desire to examine the subject with true objectivity, one can only conclude the present sorry state of FAA RD is most certainly not due to the Administration alone. Until the Congress changes its ways, the problem will not be solved; and responsibility cannot be passed to "others". I was most pleased to see recently that after over a quarter century and both parties respective Administrations urgings, the Congress finally accepted that hundreds of millions, even billions of dollars were being wasted by keeping totally un-needed and unnecessary military bases open. As I understand it, a bi-partisan Committee has been formed to identify those military bases that should be closed, and no individual exceptions will be considered. This is a higher order of self discipline, and action for the public benefit, than I have seen by the Congress in many years! I cautiously hope the effort is sincere and will be accomplished. While such and similar activity is not directly under this sub-committee, the impact of such decision is most assuredly applicable, impactive and directly to the issue before us. Congress alone prevented the FAA from similar action in 1982, and the RD program has been affected for the period subsequent because of dollars used to keep open un-needed facilities which could have been effectively used for good RD.

But the far more pressing issue is the totality of the FAA RD program which now exists as compared to what should be. While the selected two individual items above hopefully showed why the present program is absolutely not satisfactory, the magnitude of the total void is yet to be offered to the public for comment; if even known or considered. How did such come about is perhaps worthy of pursuance by others, but my desire is to stay with the subject itself, and at least try to offer beneficial input. The present RD program is funded at probably half the level that it should be. Such a statement probably prompts a response to the affect that "DOT has carefully considered and reviewed the needs and etc etc." I have never seen, and do not now know of, any capability in DOT to appraise the FAA RD program, and its requirements to meet their statutory obligation. DOT has neither the technical competence, the managerial experience or the operational impact awareness and expertise to undertake such a review or decision.

FAA could not productively absorb an immediate increase in

funding to the level reflective of the need. A program should be laid out to raise, over the next three years, the RD budget to the level in the fourth year of approximately twice that existing today, and within such funding a specific Congressional exclusion that such funds may not be used in support of development or test of any hardware or subsystem etc associated with the NAS Plan; except that certain Software research may be conducted which supports the objectives of the NAS Plan, but not internally or by a Contractor furnishing hardware to the FAA. FAA should be excluded from conducting Basic Research; it has no need. It is possible that selected efforts by Universities and non-government Research Instituitions could undertake such efforts, but I am unable to identify any such need at this sitting. I can see no need whatever for such efforts internal within the FAA. Probably no less than one third, or more than two thirds of the RD program should be contracted from outside the Federal Government, although very close association with NASA is required, and such funds are not included in the above. Some interchange of funds and/or effort between the two both presently occurs and should be continued, and encouraged.

In summary, the present program; is not acceptable, does not meet either or both the needs of the traveling public and the expectations of those who are paying into the Trust Fund to gain future benefit, is not oriented to the "future event" thinking and planning, is underfunded, and is controlled in OST by "cost", rather than by "comprehension". OST posture as regards review of the FAA RD budget has been presented to the public as necessary "oversight"; while factually it has been internal political "overtight". Initial review discloses not one single event, development, concept, new effort, technical contribution, operational enhancement, or any other <u>positive</u> can be documented as coming from OST. The record is overwhelmingly negative, with some few elements of neutrality. The strongly needed FAA RD program has become a prisoner in the bueracracy of the OST staff BYLC*, and MUST be pulled forth to reality. (*Bright Young Lawyer Crowd)

(3) The future; a recommended "core program"

A formal long range RD program should be developed by the FAA, reviewed extensively internally, consulted with the Industrial community, and then presented to this Sub-Committee. Equally, this Sub-Committee must both acknowledge and lead other House members and committees to at least one of two conclusions: (a) Good Research and Development is not compatible with singular year funding, and/or, (b) Some other mechanism must be found to monitor and evaluate RD; it simply cannot be satisfactoriloy done on a basis of only an annual program of authorizations, appropriations, and containment in a Dept. Of Transportation Budget dispersed to Bureacratic shapes, irrespective of results. Research simply does not fit that comfortable accomodation. But I have examined various subjects in depth now for some sixteen months, and am absolutely

convinced; their is a way to do it better!! We should initiate a central core program, from which necessary RD could be directly identified and placed in relative order for funding.

The combination of speed, memory and software for computers together with the now existing capability for high speed digital telecommunications now places us in an environment whereby we can develop a "dynamic simulation" of the Air Traffic Control system AND its operating environment. Because all the problems are present, we should start first with the New York area, with close following in software for Los Angeles, Chicago and probably Atlanta. For the initial effort, we could duplicate the existing airways structure, analyze the best routes and changes thereto, evaluate the location of existing and expected performance of new equipment, consider how the Aerospace Plane is going to come into the system and be handled, treat both helicopters and float planes on the East River, evaluate the potential of both the vehicle and the resultant much reduced land geography needed with the new tilt-rotor air vehicles that will be here in the mid 90's, vary the weather and determine the affects on stream "back up" from planes that left their departure point hours before, evaluate the geographaic location of various possible alternate new sites for airports, evaluate the full potential of TCAS, Data Link, AWOS and many other sub-systems that will come on-stream from the NAS PLan. Then we should go into phase 2, creation of a mini New York "approach control", complete with FAA controllers, are private contractor equivalents, and let them both evaluate the on-going efforts AND show how the airspace could be more safely and effectively used. Finally, we should initiate phase 3. Todays telecommunications capability allows us quite easily to take advantage of necessary training that goes on every day of the year. We could tie in the simulators of Eastern Airlines in Miami, American in Dallas, United in Denver, U.S. Air in Pittsburgh etc, and let the actual flight deck crews become part of the simulation even while they are performing their regular refresher checks. From such an effort, we would be able to identify with far more firmness the needed RD, new equipment performance specifications, and new or revised operating procedures to accomplish the stated objectives.

Then, we should go one step further. We should include in the dynamic simulation the capability to trade the above off against a true high speed train. The French train routinely runs at 160 mph; the Japanese have exceeded 300 mph with their train, and routinely run it between 225 and 250 mph. Dont we really owe it to the U.S. public to evaluate such a concept, and compare the cost with building multi-billion dollar new airports? The dynamic simulation would provide us the criteria of performance necessary to determine the proper balance between aviation uses for passengers and possibly high speed trains. I am in no way proposing the FAA get involved in trains: what I am trying to do is show that such a program would give us quarter century look ahead and identify

problem areas needing research to help us make the proper national answer. Why start with it in Aviation? Its needed most there, now! This country is no longer a maritime nation. This country has taken some 55,000 miles of track out of the nations railroad system in the last fifteen years, some 25% of the total existing. The highway program produced a wonderful national grid for automobiles and trucks, but it peaked out in the late 70's, and is now finishing up. Its future lies in solving the urban grid-lock in metropolitan centers. But every study, every projection, every source of information I have seen concludes that Aviation is still on the ascendancy, still growing and will continue to do so through the end of the century. That area needs more RD NOW, and is the logical place to start.

Finally, to insure continuity and dedication to original purpose, the dynamic simulation effort should be placed in a new private corporation, much like the U.S. Airforce did with Aerospace Corporation to undertake the new field of ballistic missiles. Under direction by the FAA, such an effort would maintain focus on the subject, and be able to show a budget requirement for years in advance, thereby giving the Congress full exposure to the effort and still insure the funds are used for that purpose only while holding the FAA accountable to insure the other elements of the on going Agency work, including RD both in-house and contracted out, respond to the results and findings of such an effort.

I hope this Sub-Committee will again, as it did with me in 1981, now look far in the future, and consider such a program to provide continued stimulus for the economic growth of the country, so vitally dependent on air transportation.

Mr. McCURDY. Thank you, Mr. Helms. That's an excellent overview, and you certainly did get our attention there, and you anticipated fully where we wanted to take this hearing. That is, to look at some of the current problems, some of the deficiencies, and then, of course, to look at the future.

I'll spend a few minutes a little bit later on your dynamic simulation model, because that is an intriguing concept. It makes a lot of, you could say, horse sense. It's good common sense, and I've finally gotten DOD to start looking at computer simulations on battlefronts, and there's all kinds of war gaming that goes on. And that certainly influences the R&D efforts in defense, as we look at the threat.

Basically you're doing the same thing here. You're looking at a long-range planning effort, and you've been associated with R&D for some time.

And I guess we really have to condense it down to one basic question, which is, how do we convince the Department of Transportation and OMB and, indeed, even the Congress—some portions of the Congress, not this Committee, but others—that the research funding is needed.

We always have this big hump there. OMB likes to keep a budget effort there, and it makes their books look a little more balanced. You know, it's not, in fact, the case. It appears within DOT to compete with other programs.

Do you have any just practical suggestions on how we energize the next Administration? We're probably too late into the game on this one. But what can we do to highlight the need to form this research effort?

Mr. HELMS. I don't have any magic answers, Mr. Chairman. My experience thus far has been that I have never received a new concept, a positive suggestion, a creative thought from the staff at OST or DOT as regards research. I've only received negative inputs for new trial solutions. Well, first, I don't expect to get any origination there.

Secondly, to the extent that OMB or the Administration is approached, it would seem to me that it's going to take a longer term effort.

Now is the time to start. This Committee can't do it by itself. It's going to take the combination of the industry, the users, all the people working together on the simple basis that we're falling behind.

What we're talking about is falling behind in not just safety. We're talking about in jobs because, one way or another, there's going to be high speed trains, or there's going to be newer aircraft, or there's going to be space planes, and those jobs are going to be somewhere.

I just think they ought to be here. So, I think in summary, I don't have a short term solution. I might make note that one of the advantages of not working for anybody and being completely independent is you can say what you think when you want to.

I am pulling together a summary of all of the matters and all the items which truly, in my view, are good for aviation and technology in this country.

I intend to present them very actively at both the Republican and Democratic conventions. I think that they need to know it.

Mr. McCURDY. Well, you've got some—you're preaching to the choir here, but we need to get this out and we need to make this message known and it has to be clear.

One of the concerns, one of the early examples you used was CAMI and the Technical Training Center also. Our experience, and we held a hearing in Oklahoma City on the CAMI issue, and I must admit, I guess there's one instance I was kind of glad it wasn't in my district, even though it's adjoining, that that was one of the sorriest examples of management that I'd ever seen.

It took a facility that, at one point, was a premier facility in the country when it came to research and human factors and flight safety and many other areas, and allowed it to atrophy to basically a bunch of number-crunchers and a few statisticians, that it had forgotten any long term outlook for research and development for the FAA.

Part of that problem, I think you hit accurately, was the fact that they were kind of left out there on their own and they were bypassed in that loop.

How can we prevent those things in the future? Have you looked at—have you been advised as to the HumRRO Study and the NAS Study and all the other so-called reports floating around out there?

I've been concerned and I would like to know your opinion as to whether there's anything in there specifically on R&D, and, also, I'm inviting your comment about the reports themselves.

Mr. HELMS. I'm familiar with the reports, Mr. Chairman, but I'm not familiar with them in detail and in depth.

Starting in 1981, I felt that we had to be able to focus the efforts of CAMI more directly towards their area of specialty and professional capability.

You recall it was during that time period that we started a new program of, and I'll use exact examples so that you can follow it, where the interior lights ought to be, because the lights in an emergency are always at the top.

But after we conducted about a year or a year and a half of research, we found that that's not where people's eyes are, and people always get to the floor, and the lights ought to be down there.

So, I used that as an example of the type of work, then, which we started to pick up and provide increased funding.

And the funding level for CAMI was on a continuum increase up through 1984, as I recall it. I know it was in '82 and '83. To the extent that we wish to use it, we have to first establish the objectives, what it is we want that organization to do. Secondly, set up the criteria for evaluating performance against those objectives. And, third, fund to meet them.

We're not prepared to do all three. We're not going to get there. It's just that simple. But, to the extent, then, that the agency has identified what the objectives of CAMI are as part of the overall agency R&D, and the reason that I'm most concerned that we keep this a single point, is the entire technical engineering development function under one person so he's not accountable for all.

The research is not being done by somebody else who wants to study research. Rather, that research is being done to support the objectives of the technical functions within the FAA on the long term goal.

To the extent, then, we establish those objectives, to the extent that we set up a means to monitor it, both internally and for the oversight of this Committee, and fund it, I think you can achieve what we're talking about.

I personally would like to see it continue that way.

Mr. MCCURDY. Is there a need for it? I mean, I've played devil's advocate and I did it in Oklahoma City also, and I asked the people there, I said, why even have this facility if it's not functioning.

I mean, obviously it's work that could be done elsewhere. Is there a real need and what is the mission as you see for it?

Mr. HELMS. I personally believe that there is a need for CAMI. I personally believe that the organization is not, as yet, satisfactorily interfacing with the Air Force's aerospace medicine program in San Antonio.

An example in the area of human physiology: each of them are duplicating a little bit. The Air Force is quite far ahead in some areas, and CAMI is ahead in others, and to a lesser extent, the Navy. I think in the area of interactive devices and human man-machine interface, there should be a closer coordination.

To the extent we're talking about treating billions who are not used to being in airplanes, who are not engineers, they're not technicians or others that are going to get on an airplane and get off and want to do it safely. I don't know of any place in the country that has as much knowledge about how those people react and act as it's done in CAMI.

We should respond to that, not necessarily so because of research, but respond to it because that's our public trust of the citizenry.

I have no doubt we should keep CAMI, but it ought to do a better job of interfacing with some of the other institutions.

Mr. MCCURDY. Well, they've delayed by a couple months their report that is due to this Subcommittee.

We keep hearing that the check is in the mail, that the report is in the mail, one of those kinds of answers. But we will be looking at that very closely. I agree that there needs to be a——

Mr. HELMS. Excuse me. I might use another example to point out, now, it's awful hard to draw this line in there. But, for example, I was criticized very strongly, which I don't mind, that's the name of the game, because I had put emphasis on being able to identify birds through feathers and small feathers, all pieces.

I was taken to task on this in 1983, but why on earth would you spend FAA money for that. But the reasoning was, and has since been proven to be true, is if we're going to lose an airplane because of a bird going in the engine, let's find out what kind of bird so that we can either trace it's migratory patterns, put the air routes around them, know whether we've got to put screens in, et cetera.

So, the intent was to try to find out what kind of birds are in a given area to the extent, then, that they can knock an airplane down.

Out of this we found that there were 17 different types of gulls around the Philadelphia Airport. From that, we moved a garbage dump because of it.

So, the point I'm trying to make is, you can't always establish clearly where they ought to be in that area. Good research will have an objective and that's what we're talking about.

Mr. McCURDY. Very good. I just wanted to ask one other question, but I want to yield to my colleague from Florida.

Do you think that the FAA could benefit from an outside advisory committee? I know administrations are loath to have people looking over their shoulders whether it's Congress or outsiders, but we've had some, we think, good success, at least this year, in having an Aeronautical Advisory Committee work with those at looking at the NASA aeronautical program.

Do you think the FAA could benefit from that approach, or what would your preferable approach be?

Mr. HELMS. I believe it would have very little practicality as long as the FAA remains part of DOT. You would get a good technical report, you'd have a lot of people sitting around talking, but the BYLC, that's the acronym for the Bright Young Lawyer Crowd, makes up the staff over at OST, would emasculate it anyway.

So, once you get the FAA out of OST, then, such a guidance group, yes, I think would be a very positive group. But not too large. Seven people is an absolute maximum, or say, maybe five, and it should be tasked to meet with the administrator not less often than quarterly. And it should also be tasked, when in doubt that the administrator is making decisions that are properly directed toward either the safety or the smooth efficient functioning, to come directly to Congress. They go to the Administration and they go to Congress.

I have found that when I had a Board of Directors. And there's nothing that will hit you like there being a Chairman and a President and Chief Executive Officer with an independent board. And the first time, I was a little bit scared of it. I also found that that was the best thing that ever happened to me. Those people bring a breadth of experience and expertise and independence that no single individual can have. I have found that those people are just never intimidated by me as Chairman or Chief Executive Officer. So, if you choose the right five or six people and the agency is out of OST, I think it would be a tremendous benefit to it.

I think you would have additional confidence and it would be filled with people there that could come directly to you and the Administration and tell you what's going wrong.

Mr. McCURDY. Tom?

Mr. LEWIS. Mr. Helms, how would you suggest that you could make FAA autonomous? Right now, it's under the Department of Transportation. Would you suggest that it be removed from there? I would like to know how it could be relieved from some of the pressures that it has placed upon it.

Mr. HELMS. When this subject first was put to me, Mr. Lewis, about, oh, I'm going to say 14–15 months ago, I was a little bit cold on it. It always sounds good to quote, "organize yourself out of problems." From my many years in industry, why, I've just never

seen a group do that. You get out of problems with people making the right decisions.

So even as late as early last fall, I really wasn't convinced. I then started a more detailed look at the decision-making process and what had happened. Now, I am a very strong advocate of getting the FAA out of the Department of Transportation.

Clean up the procurement problem. Clean up the time that's involved to get decisions. Get it out of the political area and back into the technical function which it ought to be.

Therefore, the combination of S. 1600, Mr. Ford's bill, and the first drafts which I've reviewed of Mr. Oberstar's bill, which would go together and create a separate function, just as NASA is, with perhaps one or two other items that I would write into that legislation. I'd write a new bill, and just take it out as easy as we put it in. And I think it could be done.

Mr. LEWIS. The first thing that happens on the budget reductions in the private sector, as well as in government, when you have to cut back is, you cut your R&D.

What do you think is a reasonable percentage of the budget for FAA that should be in R&D?

Mr. HELMS. I'm going to agree with you that the first thing you ordinarily do is cut R&D, but usually I have found that people cut training, because, they say if the budget cycle turns around, I can always pick that up in 3 or 4 years, and I can get my training program going back again. But good R&D goes long-lead. So I'm certainly going to say that's the second one.

I believe that the present funding level of the FAA's R&D program is about half of what it ought to be. But I believe also, that if for some reason we could waive a magic wand, and right now create, it would be erroneous to increase it by 100 percent in one year. The infrastructure, the objectives, capability of identifying what it is we want to do, is just not there yet.

Though a program that says, we're going to start increasing it over the next three years, and we're going to tell the rest of the Congress that we're letting you know that in four years from now, we'd like to be at about twice this level, so that now we can develop and pull in the talent to be able to manage it effectively. Use the universities, use the outside research organizations.

And I believe, oh, perhaps not less than a third, but certainly not more than two thirds of research and development, should probably be done outside. There are certain areas that must stay within the FAA.

Mr. LEWIS. Do you also believe that the Congress should be addressing the fact that problems continue to occur on the annual budget—that we should be looking at a long term budget situations for FAA, as well as we should be looking for defense and aerospace, so that you can continue down the pike on an R&D program and reach a logical conclusion over a period of time?

Mr. HELMS. Yes. When I first started to interface with the Congress 20, 25 years ago, I wasn't too sympathetic with the annual appropriations and authorizations. But after 10 or so years, I began to understand it. And I must say, for the last 10 years and even as administrator, I don't know if anybody took a harder time than I did on certain areas, but you know, I really didn't mind, Mr. Lewis.

I found that just like the National Transportation Safety Board, it's kind of nice to have somebody sitting there and looking at you and saying, are you sure? Confident you've done everything you can to make this thing come off right?

So now, within that context, I still think that we should have 5-year authorizations. But I would very, very much like to see the House, and incidentally, I'll interrupt to say that Senator Kassebaum has indicated that she would try to modify the Senate bill, so there would be one bill in the Senate. It would be a combined authorization and appropriation. I would very much like to see the House do that also. And that would be part of creative language.

From the time the appropriations bill and the FAA's bill this year left authorizations until it came out of the Appropriations Committee, over 30 place-namings had occurred. That involved millions of dollars which had to come out of your research program, collision avoidance systems, all the research things which we're talking about, because when the people add those in, they never increase the funds.

So, I would like to see one single bill if we could, and I'd like to see the trust fund used for it. There would be nothing wrong in using that trust fund very heavily for R&D.

Mr. LEWIS. I'm a real advocate of computer management models. How would you propose that we could get into a simulation program such as you suggested in your initial comments and through most of your comments, to reinforce the NAS systems as well as coming up with the headaches and problems that we could see down the pike, or what would the tradeoff's be if we got into budget scrapes? How would you propose to do that?

Mr. HELMS. I've studied this now for about 16 months, and I'm going to just give you the results of that, and I in no way want to imply to the Committee that I can quantify this in great detail as yet.

The first phase would take about $4.6 million, not counting the machine time which would be done to validate that such a concept will work and it can be done. For example, can we really make such a simulation model, over a period of the next 2 or 3 years? Before we start launching into it, let's examine it and see, can it be done, and in what timeframe, and what schedule, and what are we buying into?

So that could be done in about a year, I think, without too much difficulty. To the extent then, that we do that, I also think that if you want to put continuity in the R&D program, make sure that this is going to give us the 20- or 25-year look we're talking about, that flows out ideas.

Let's put our arms around the funding of it, by taking it quote, "out of the FAA to the extent of the day-by-day work," and create what the Air Force did for its ballistic missile program—create an Aerospace Corporation solely for this purpose.

And now then, have the FAA manage that aerospace corporation, which in this case of course, would be the simulation program, and during that first year, that could be accomplished. So we would then at the end of the first year, both have confirmed it can be done, created the paperwork and everything for the new corpo-

ration, and be underway to get going with it. That's the way I think it could be done, Mr. Lewis.

Mr. LEWIS. Do you see any solutions to the safety problems where we see managing trade off situations in the cockpit with air traffic control?

Mr. HELMS. I'm not sure that I understand the question, if there's some thought other than implying that there's some problem in communication.

First, the digital data link will do far more to help us than anything else. It will reduce the needed transmissions between the controller and the cockpit by over half. But therein alone, we start to reduce the potential of error.

Secondly, it will provide so much more information to the captain, if he wants it—even to the point of having wind shear information presented to him from the terminal radar, if he wishes. So, the digital data link will solve that.

I don't know of any problems at all, that I don't see any I'll say, that would imply a conflict. The problem in my mind is, we're not conducting any research to see, can we do it, and see how the two pieces, flight deck crew and the controller, are going to react to it. That's what worries me.

We have people that will say, AERA is 4 years away, or 5 years away. Now is the time that we should be examining the problem for AERA, not wait till we get it here and not know how to use it.

Now is the time that we should be looking at other applications for TCAS, and for digital data link. Let's don't wait till it's sitting on the ground here 5 years from now and we don't know how to use it.

So, I don't see any problem between the flight deck and the controller. I can envision that the controller's job is going to be made easier, not less responsible.

Mr. LEWIS. Do you see where there would be severe problems arising if we had a typical type of condition forecasted at a major airport of wind shear conditions to prevent landings and takeoffs till that wind shear condition was eliminated—closing the airport for landings and takeoffs until the wind shear condition was remedied?

Mr. HELMS. Yes, our problem, of course, in the past, has been that we did not have the technology to be able to accurately forecast that. But by having the wind direction indicators spread out around the airfield was better than nothing, but it was rather rudimentary.

But the new Doppler radar does give us the opportunity now, in the very short-term future, if the funds will come out of the trust fund, to have that available.

Now, the advantage of that, Mr. Lewis, is not only that we can change runways or close the runway. In fact, if there's some question about it, and at the rate it's developing, we can take that radar in through the digital data link, present it on the CRT in front of the pilot, and he can take a look at it himself.

Through the same techniques, it can now be presented back in operations offices—United Airlines in Chicago, or American in Dallas, even on the airplane that's going to land at Cincinnati. So

that now they can start to evaluate whether we want to have the airplane even try to land there or go somewhere else.

Technology offers all of these kinds of possibilities. To the extent that wind shear itself is a unique item, I don't know that I'm satisfied we have our arms around it completely, but I think the new Doppler radar is going to be the largest step forward. And the quicker we get it installed, the safer it will be.

Mr. LEWIS. That's all the questions I have right now, Mr. Chairman. Thank you, Mr. Helms.

Mr. MCCURDY. Mr. Helms, earlier you made the point about the need for a single point within FAA for managing the R&D, at which level you put it, but the FAA is currently moving toward splitting the R&D responsibility into two offices.

I take it you would disagree with the FAA plans, and could you explain a little more how you would see that person managing the R&D?

Mr. HELMS. I'm not in detail familiar, Mr. Chairman with what their current plans are. We spent three hard years picking two and a half engineering departments and putting them together, so that we had a single point authority for engineering, systems analysis, and research elements, and cradle to grave responsibility for the design of something until the time it went into service.

It just seems to me, I guess, that based on what I know, that it is not the time now to start to separate these. Because to me, the person who is the quote, "chief technical officer," is just like the chief financial officer. I just don't think there ought to be two chief financial officers. I don't think that there should be two safety officers.

The senior safety officer of the FAA is the administrator. So I'm not quite comfortable with separating these, because I don't know how they're intended to function. There may be a good rationale for it, but if so, I'm just not aware of it.

It does cause me some concern, however, that we're going to place the R&D function separate from the person who is responsible for the ongoing engineering design of the systems that are going to be in service in front of us over the next decade.

Mr. MCCURDY. One last point I want to cover before going to our other colleagues is, in my opening statement, I mentioned both United and the Aloha crash—more recently the Northwest Airlines accident in Detroit. The pilot apparently forgot the flaps. Continental in Denver—two inexperienced pilots took off in a snowstorm. United, of course, in Tokyo 2 days ago, which initial indications are the possibility that they ran out of fuel.

You know, about 60 percent of this year's R&D budget is for air traffic control-related problems. But the most recent incidents have been non-ATC related. It just to me, underlines the point time and time again, that you made earlier—that is, we're not doing enough in these other areas.

And we have to increase the budget by 50 percent to get there. That may be on approach, but until we change OMB, and we change some within the Appropriations Committee's attitude opposed to this, we're not going to get there.

Mr. HELMS. It seems we can always get there after the accident.

Mr. MCCURDY. It takes them to happen before we get there.

Mr. HELMS. It was about 5 years ago, I think, when the first 747 landed at Newark, and all four engines quit before it got to the terminal for lack of fuel, Mr. Chairman. So these are not new. What we should be doing, is taking what we know now, applying them to the future. That's the reason why I felt so strongly that it's the professionals that built this fine system—the best system in the world over a half century. But those are the ones that can project ahead.

Even though this has gone long, let me give this Committee an example now, of how technology has changed the impact of training and the requirement for flight deck training for the crew.

At the end of World War II, the average TBO, time between overhaul, of the general aviation engine and other engines, was about 400 hours. When the DC-6's, Constellations, DC-7's came along, all the airlines programmed that they would lose an engine or propeller in flight about every 2840 hours. So the crews prepared and trained and did everything all along, because they knew they would lose one.

Today, one carrier has an unscheduled engine removal every 43,000 hours for every power plant. We are now to the point where flight deck crews can live their entire career and never have an engine failure. When they have one, what are they going to do about it?

So therefore, what I'm saying is, technology has brought us to the point now where we must take a much harder look at the training courses. We have proven the reliability of the equipment. Now we've got to use technology to reactivate the capability of the individual.

Mr. MCCURDY. Very good. I'll tell you, these Aloha pilots ought to be commended.

Mr. HELMS. They did a fantastic job.

Mr. MCCURDY. That's an incredible feat, to bring that in. The gentleman from Kansas.

Mr. GLICKMAN. Thank you, Mr. Chairman. Mr. Helms, it's a pleasure to see you again, and I don't know whether this subject was brought up before, but for a large part, you were the catalyst behind the NAS plan. And I suppose you take the good with the bad with it.

Mr. HELMS. I take the bad with the good also, and I must say, that as chairman, I wouldn't have had a NAS plan if it hadn't been for you, and I appreciate it very much.

Mr. GLICKMAN. Well, I mean, you were the prime motivator behind it, and the country owes you a great debt of gratitude for moving us along towards the recognition that we had to modernize our air traffic control system and the spinoff's that it was going to have. And because of that, this Subcommittee went ahead and passed a resolution.

I think I remember, it was H.R. 202, which started the ball rolling, in order to get the process moving ahead, and you are owed, indeed, a great debt of gratitude by this country—both the people involved in aviation and outside of aviation.

I wanted to ask you a question. You know, it's a little bit along the lines of what Mr. McCurdy mentioned. I don't know about prophetic, because I'm not sure it's great to be prophetic when there's

a catastrophe. But on June 4, 1986, this Subcommittee had a hearing, and we called it Geriatric Aircraft, Aircraft Maintenance During an Era of Aging Commercial Fleets, a pretty prophetic type of title for a hearing, and particularly after what happened with the Aloha plane.

And as part of this hearing, Mr. Brown was then Chairman of the Subcommittee, but during that, in an opening statement that I made, I said the following—and I was talking at this point—it was before Mr. Broderick, who was assistant administrator, and then Jim Burnett, NTSB:

> As new carriers enter the marketplace, they can buy older airplanes much cheaper than new ones, so you see older DC-9's, older 727's, both the stretched and nonstretched variety; older propeller airplanes being utilized to transport people, sometimes under conditions which require dramatic utilization of those airplanes on a day-to-day basis. And I think one of the things in our hearings today, ought to be to explore the useful life of these older airplanes, particularly as they are being utilized in ways that probably were not intended by their manufacturers.

Is that just as true today as it was 2 years ago, in terms of characterizing the state of commercial aviation today, particularly how airplanes are being flown today?

Mr. HELMS. I think, perhaps, with regard to how they are flown, they may be similar, but I'm not sure as to exactly how they're being designed and how they're being manufactured. I should expand on that just briefly. I am concerned that in the next 15 years, over 50 percent of all the captains flying scheduled airliners in the United States are going to retire. We will have passed the age.

Now, then, I don't think we have the sufficient training program underway in the country to be able to replace those with experienced ones.

That means that the regional carriers' people are going to fleet up, the others are going to go in. So, I am concerned about the gap 10 years and 15 years from now. The other reason why I want that dynamic simulation model is so that we can practice on emergencies. We can practice on these events before we get there.

But to the extent that we're talking about aircraft, my greatest surprise was in learning, and I caution I do not know this fact too—but the information I have is that the aircraft involved in the Aloha incident had had nearly 90,000 landings. The aircraft was never designed for that in its original time period, I'm sure. So, the idea that, at the time the airplane was conceived and the metallurgical properties were chosen, that was one set of conditions.

Mr. GLICKMAN. And that was to what, 20,000 landings?

Mr. HELMS. No. It's usually—in that time period, it was in 50 to 70,000, after what we call a D-check. The aircraft would go in for a D-check, which is essentially taking it completely apart, examining everything, putting it back together at the critical areas, and by virtue of that, you're on pretty firm ground.

Then, of course, we come into the new situation of the composites. The composites have no fatigue factor. So, we're in a position now to where we're going to be able to design the airplanes for 90 to 100,000 landings, if you will.

And to the extent that we can assure that the load bearing structure is of the right composite material, there's not going to be a

fatigue problem. So, this transitions, if you will, through it. This was recognized by the FAA early in 19—probably in the late 1970's.

But, in 1982, I was faced with a situation about what we were going to do about the 767. In 1983, it became evident. The 767 was going to be such a fine airplane and the reliability factors on it were such that we were going to penalize the machine and its capability and the new technology by saying we had to stay within the 60 minute rule for flying over water.

Going back to my earlier data on engines, engines just don't fail anymore. So, what I did was create a scenario in which one of the airplanes flying over the North Atlantic in the wintertime, had an engine failure of a catastrophic nature, similar to the one that happened by U.S. Air, and it went through the cabin, lost his pressurization, hence, had to come down to 12,000 feet for the passengers aboard, which happens to be the maximum icing level in the North Atlantic in the wintertime, from 6 to 18,000, and had to have enough fuel and power not just to get over to Iceland—either back to Iceland or to the airfield in Greenland that I've been in a number of times.

But it also had to have enough excess energy capability in the engine to keep the airplane de-iced. When I levered this combination on Boeing and said I must also, now, because your flight time is going to be longer, you must now show me a greater capability to control fires inside the fire compartment, and since the greater potential failure rate now is in avionics, I now want to see a way of cooling the avionics if you lost that engine.

Their immediate reaction was: you killed our airplane. It is the finest airplane today, because of that, that there is. So, what I'm saying is these things move through stages, Mr. Glickman.

We take advantage of technology, but I don't know of a single thing we're going to be able to do to take those old aircraft and, in some way, put them back together for 90 or 100,000 landings and have it done without a major upgrade.

Mr. GLICKMAN. I guess that what concerns me is that in this transition phase to the newer generation airplanes that have 20, 30, 40 useful years available to them, we are dominating American—world aviation today by planes that really may be extending what their original useful life was, along with pilots that are a different breed than they were before.

The Air Force isn't producing as many pilots as then go into the commercial sector, or whatever sources they were.

Mr. HELMS. I think that's correct, and when you start to concern yourself now with fatigue and pressurization, we have what we refer to; what's called a scatter factor. That scatter factor is used in the design of an airplane, and it's also used with the approval of the FAA. We have learned a lot more in the 25 years since we had jets.

Remember the first Comet—there was an error there. We have now started to encounter the first part of that in the Aloha Airplane. Though, it's going to get better but I don't see any way right now, without a major inspection and there's going to have to be increased inspections, probably going to have to be some repairs done to the aircraft to keep them in service.

Mr. MCCURDY. If the gentleman will yield here just a minute. I am called away, I have an amendment on the Floor on the Defense Bill and I have to go see to it.

I'm going to ask the gentleman from Kansas to Chair. Mr. Helms, thank you, as always, and we appreciate your input.

Mr. HELMS. Thank you for the opportunity, Mr. Chairman.

Mr. GLICKMAN [presiding]. Mr. Walker?

Mr. WALKER. Thank you, Mr. Chairman. I, too, want to welcome Lynn Helms here, having worked with him on a couple of different assignments while he was Administrator, and he took an agency that was in some state of turmoil and brought us, I think, into a new era where we did stress some safety factors and a lot of other things. I, too, want to thank you publicly for all you contributed to the nation during your period as an Administrator at FAA.

Mr. HELMS. Mr. Walker, it's nice to see you again and one of the advantages I found with you on the Committee is while you supported me vigorously, when you disagreed, I sure better dig and find out why because you usually had a good reason.

Mr. WALKER. Well, we try to keep everyone at least basically honest. Tell me, if you started with the universe, understanding, as you stated, that we had the safest air traffic system, that is, the safest air travel system in the world, but if you take that percentage which is questionable, and you call that the whole universe, by what percentage could we increase safety by using state of the art technology at the present time?

Mr. HELMS. I don't think I could quantify that, Mr. Walker. There are just too many variables. Trying to put them all together and do so without considerable thought, I don't think I could do it, and I doubt I could even then.

There is no question in my mind that it could be improved. When I stop and think that the first scheduled airline fare, as I recall, was across Tampa Bay in the 1920's, here we are 60 years later, we've squeezed an awful lot out of it, but there's no question in my mind there is far, far greater capability ahead. There's more growth left ahead. I just don't know how to quantify it.

Mr. WALKER. Well, the reason why I asked is, I mean, to some extent we, in government, like people in business, have to look at the investment that we're making. And a lot of people look at the amount of money that's sitting in the trust fund there and say, okay, you know, we ought to be spending that money on air safety and I don't think there's anybody who disagrees with that.

The question always is, is that you have to arrive at a point of time when you make the decision. At the point that you make that decision, you lock in a certain state of the art technology, at that point, and you begin to buy, based upon the state of the art. There is no doubt in anybody's mind given what you've just cited the fact that by the time you put that technology in place, it's going to be obsolete, that we will have spent our money on something which then is almost by definition obsolete by the time that it's in service.

It seems to me that to some extent, we in government who have to make those policy decisions do need to quantify just exactly how much of that trust fund money we spend at any given time, and what we spend it on. To say we simply take all of the money and dump it out right now because that is obviously going to make

things safer, yes, it could, in fact, make things safer. There's no doubt that that investment would have to have some incremental effect on safety. But it may also be that the next step two years from now in technology would make it a wiser policy decision to wait until that point and buy the next step more technology, and so on.

And that becomes a very difficult decision. That's the reason why I was looking for some quantification based upon state of the art technology as we now know. What is the wise investment, because we, in this Subcommittee, as we look at R&D, really do have a difficult time making that decision.

Mr. HELMS. The distinction I think I was trying to establish, though, Mr. Walker, was I agree exactly with both your posture and what you said. The question in my mind, however, is that when I can look at what is not being done, and identify a specific project which would contribute to safety, then there's no question in my mind the budget's not enough. But at the same time, I can't examine it and say you will get an eight percent, or a five, or a 21 percent improvement in safety. I just can't quantify that.

Additionally, there are other elements that are going to contribute to the safety of the system which would not require any expenditures. For example, we talk about the crowded skies. It's great in the media nowadays. The near miss. Everything is there. In fact, we're only talking about 15 or 20 major metropolitan areas. If you get above 18,000 feet across the United States, the skies are lonely.

Now then, to the extent, then, that I'm going to leave the East Coast and go to the West Coast, if I'm going to have to stop—the airlines insist I stop, I don't particularly care to stop—in O'Hare. I don't really care to stop in St. Louis because of the long walk and the jam up. I'd be quite satisfied to stop at Oklahoma City, Wichita, Cheyenne, Memphis.

What I'm saying is the airlines are not using the additional excess capacity of airports that exist right now, and that's the reason we, as an institutional group, aviation, have not sold the American public on the need, because there is excess airport capacity, and there is excess airspace capacity. It's just that we're trying to respond actively to the airlines on those narrow areas that we've talked ourselves into it. What I'm trying to get them to do is say, every time, now, that you've come up with a need, you've said, well, I'll establish a mini-hub.

If you do that, the regionals respond just like that. Every time an airline selects an area for a mini-hub, at Raleigh-Durham or Dayton, the regional carriers within that 200 mile radius, within 30 days or 60 days, they're flying them in and it becomes a new business activity. Why can't the airlines change me in Oklahoma City or Little Rock or somewhere. What I'm saying is, that would contribute to safety also.

I don't know how to quantify that, though. That's my problem. But I can take a list of the items that I know should be being worked on now that are not being, and I can, in my own mind, say we need a budget that's about twice where we are right now.

Mr. WALKER. But that would change the direction of resources because, obviously, if you make an airport in Little Rock, for exam-

ple, a hub airport, we are going to end up having investments out of the trust fund into that airport which then are monies flowing out of the trust fund that could be flowing to other places. I mean, that is, in fact, the policy distinction that we are left in a quandary about from time to time.

Mr. HELMS. Yes. And to the extent we're talking about using the trust funds for that, to me, it's perfectly normal. My difficulty in trying to respond to you is I don't know how to quantify the safety contribution. I just don't know how to do it.

Mr. WALKER. Thank you, Mr. Chairman.

Mr. GLICKMAN. Thank you very much, Mr. Helms. Pleasure to see you here again today.

Mr. HELMS. Nice to see you.

Mr. GLICKMAN. Next we have a panel. Mr. Jean Caffiaux from the Electronics Industry Association; Mr. Jack Fearnsides from Mitre; Dr. Richard McFarland from Ohio University; and, Ms. Edith Page of the Congressional Office of Technology Assessment.

We will ask each of them to give us a five minute summary, and then we'll have questions for the panel. We'll go ahead and do it in alphabetical order, starting with Mr. Caffiaux, then Dr. Fearnsides, Dr. McFarland, and Ms. Page.

STATEMENTS OF JEAN A. CAFFIAUX, SENIOR VICE PRESIDENT, GOVERNMENT DIVISION, ELECTRONICS INDUSTRIES ASSOCIATION; DR. JOHN J. FEARNSIDES, VICE PRESIDENT, CIVIL SYSTEMS DIVISION, MITRE CORPORATION; DR. RICHARD H. McFARLAND, DIRECTOR, AVIONICS ENGINEERING CENTER, OHIO UNIVERSITY; MS. EDITH B. PAGE, PROJECT DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT

Mr. CAFFIAUX. Thank you, Mr. Chairman. I am Jean Caffiaux, Senior Vice President of the Electronics Industries Association, and I am here on behalf of our members, who provide electronic equipment, systems, equipment and support through the FAA. If it is agreeable with you, I would like to have the full statement entered into the record.

Mr. GLICKMAN. All your statements will appear in the record in their entirety.

Mr. CAFFIAUX. In which case I will proceed with about a five minute series of highlights.

We just learned within the last week or so FAA has initiated some substantial organizational changes in the R&D area, but we are not yet sufficiently informed on the details of this reorganization, so we have not reflected those changes or the impact of those changes in our statement. We do, however, applaud FAA Administrator McArtor for initiating the self-improvement effort.

We request that our views be regarded by the Subcommittee as our members' perceptions of the following aspects of the FAA R&D program, based on our own experiences.

1. We feel there is a definite need for a centralized R&D organization. There is no centralized R&D organization within FAA to provide overall focus and consistency for the technical direction and funding of R&D activities. Consideration should be given to putting R&D at the associate administrator level to coordinate the

various activities and minimize duplication. This R&D effort, however, must be coordinated with the facilities and equipment side to assure a smooth transition from R&D to F&E.

2. Regarding FAA in-house versus outside R&D. FAA apparently conducts little R&D activity in-house and relies heavily on nonprofit organizations. We believe consideration should be given to (a) more coordinated utilization of the FAA Technical Center for Testing and R&D and (b) more utilization of the R&D capabilities of the for-profit companies, most of whom already have substantial R&D organizations active and in place.

There is no evidence that R&D resulting from competitively let bids to all qualified companies is any less objective than R&D performed by not-for-profit organizations. The reluctance of FAA to increase its R&D contracting with for-profit industry means it is not taking full advantage of the major R&D resources of the private sector. These are the same resources that have kept our nation at the forefront of technological leadership worldwide.

Additionally, contracting with for-profit companies can often result in synergistic benefits because of a company's technical expertise, development for defense or other Government or commercial endeavors through R&D.

3. Regarding the R&D level of effort, near term versus long term, we believe that the level of funding for R&D is small compared to the total Administration budget. Most of the present R&D budget funds special and developmental programs and is tuned to near term problems. There is little money available for investigations to uncover and test new concepts and technologies from which promising, innovative advancements for the future ATC system could be selected and developed.

We also believe consideration should be given to setting the R&D budget as a percent of the F&E budget.

4. We believe that FAA's R&D type activities must be accelerated. For R&D projects, there must be a shorter cycle between requirements to specification, specification to RFP, RFP to award, and award to implementation. This we feel is critical if the product of the R&D effort, that is, the procurement package for production, is not to be technologically obsolete at the time of delivery.

5. Unsolicited proposals. To the best of our knowledge in recent years, we are not aware of any unsolicited R&D proposals submitted by for-profit companies which have received serious consideration by FAA. We believe this could be remedied if FAA established a directive specifying the procedures for submission of unsolicited R&D proposals, including the format and content of such proposals, and the procedures for FAA evaluation of such proposals, and for FAA response to the offer in a specified time period.

In this regard we recommend the establishment of funding to support projects awarded as a result of unsolicited proposals.

6. We believe improvements are needed in informing industry of FAA's long-term R&D needs. There is a need for improved, systematic means of communicating FAA long-term R&D needs to the industry. We believe consideration should be given to a systemized procedure where FAA could communicate its long-term needs to industry and other potential bidders much in the way that the military departments conduct advanced planning briefings for indus-

tries. This would be particularly helpful in the non-NAS plan R&D areas at this time.

In conclusion, we would like to reiterate that these views are based on the FAA R&D process as perceived by industry. To the extent that our views and FAA views conflict, we urge that they be regarded as honest differences among two groups, both of whom are genuinely concerned with the need to maintain a modern, safe air traffic control system.

Representatives of our association would be willing to work closely with FAA people towards our common objectives.

[The prepared statement of Mr. Caffiaux follows:]

STATEMENT OF JEAN A. CAFFIAUX
Senior Vice President

Electronic Industries Association

on the subject of

Research and Development in FAA

before the

Subcommittee on Transportation, Aviation and Materials

of the

Committee on Science, Space and Technology,

U.S. House of Representatives

May 3, 1988

Mr. Chairman and members of the subcommittee, I am Jean Caffiaux, Senior Vice President of the Electronic Industries Association ("EIA"). The Association was established in 1924 and currently has about 500 member companies who manufacture electronic parts, equipment and systems for consumer, industrial and government needs. I am appearing today on behalf of those EIA member companies who provide electronic equipment, systems or supporting services to the Federal Aviation Administration. We appreciate this opportunity to offer our views as part of a constructive exchange which we believe will provide useful information to FAA in its ongoing efforts to improve its R&D program.

We have just learned that in the last week or so FAA has made substantial organizational changes in the R&D area. We understand that one result of this change may be to get industry involved earlier in FAA's R&D programs. However, we are not yet sufficiently informed on the details of this reorganization and so have not reflected the impact of these changes in this statement. We do, however, applaud FAA Administrator McArtor for initiating this self-improvement effort. We are hopeful that it will realize its objectives.

While we have tried to be responsive to the topics on which you requested our views, in your letter of April 20, 1988, we found we were often limited in our ability to do so since in many cases the necessary background data resides in FAA files. For example, the relative funding of in-house vs. outside R&D, or the funding for short vs. long term R&D.

Therefore, in view of this limitation, we request that our views be regarded by the subcommittee as our members perception of various aspects of the FAA R&D program based on their own experiences.

1. Need for a Centralized R&D Organization.

There is no centralized R&D organization within FAA to provide overall focus and consistency to the technical direction and funding of R&D activities. R&D funds apparently can be expended by any number of internal FAA activities. It is not readily apparent to industry if there is any prioritization or overall direction to R&D projects.

Consideration should be given to putting R&D at the Associate Administrator level to coordinate the various R&D activities and minimize duplication, including the establishment of a formalized planning and approval procedure for R&D projects. Coordination could encompass R&D activities in Testing, Software Concepts, Electronics/Engineering, Airborne Systems, Ground Systems, Radar Systems, Safety, Runway/Airside, etc. This R&D effort, however, must be coordinated with the Facilities and Equipment ("F&E") side to assure a smooth transition from R&D to F&E.

2. FAA "In-house" vs. Outside R&D

FAA apparently conducts little R&D activity "in-house" and relies heavily on "non-profit" organizations such as MITRE, Lincoln Labs, JPL and on small and minority businesses.

Consideration should be given to:

a) more coordinated utilization of the FAA Technical Center for testing and R&D, since the Center apparently has much of the space and facilities already in place to take this on. The Center could be further equipped with a super computer or high capacity processors to conduct dynamic modeling and forecasting.

b) utilize the R&D capabilities of the "for profit" companies, most of whom have substantial R&D organizations already active and in place. FAA often claims that R&D can only be performed "objectively"

by non-profit organizations. There is no evidence that R&D resulting from competitively let bids to all qualified companies is any less objective than R&D performed by "not-for-profit" organizations. Further, it could be argued that "non-profits" suffer from a lack of "real world", "hands-on" experience which could impede the timely transition of R&D into useful, fielded systems.

The reluctance of FAA to increase its R&D contracting with "for profit" industry means it is not taking full advantage of the major R&D resources of the private sector; the same resources that have kept our nation at the forefront of technological leadership worldwide. Additionally, contracting with "for profit" companies can often result in synergistic benefits because of a company's technical expertise developed for defense or other government or commercial endeavors through IR&D or contracted R&D.

3. R&D Level of Effort - Near Term/Long Term

The level of funding for research and development is small compared to the total Administration budget. It is particularly small in view of the high technology nature of air transportation and the Air Traffic Control system. It is also small when considering concerns for safety and environmental quality. Most of the present R&D budget funds special and development programs attuned to near-term problems. Often inventive ideas are tested against today's airplane capabilities and operations rather than those expected in the future. There is little available for the applied "research," i.e., investigations to uncover and test new concepts and technologies from which promising innovative advancements for the future ATC system could be selected and developed. The quality of the future ATC

systems depends on the scope and results of today's research.

The limited funding of research and development, particularly exploratory research, leads to updating the ATC system with some new subsystems incorporating recent technology but basically resulting in "doing business in the same old way." Operational problems are perpetuated when funds are insufficient to examine the system as a whole. Available and potential advancements in aircraft and airborne systems are not exploited because the existing R&D evaluation process is often not sensitive to all potential technological solutions.

Consideration should be given to setting the R&D budget as a percent of the F&E budget. Then, as the use of air travel grows, and the need for improved systems becomes greater, the necessary R&D can keep pace.

In a high technology dependent system such as NAS, R&D can never be regarded as "finished" -- it must always be a continuing and necessary function!

4. FAA R&D Type Activities Must be Accelerated

For R&D projects there must be a shorter cycle between:

- o requirements to specification
- o specification to RFP
- o RFP to Award and
- o Award to implementation

This is critical if the product of the R&D effort (the procurement package for production) is not to be technologically obsolete at the time of delivery. In fairness to FAA, this criticism can also be leveled at other government agencies when the competitive pressure of the commercial marketplace is absent. The previously noted suggestion for putting R&D

under direct control of an Associate Administrator could improve this situation.

5. Unsolicited Proposals

To the best of our knowledge, in recent years, we are not aware of any unsolicited R&D proposals submitted by "for-profit" companies which received serious consideration by FAA. We believe this could be remedied to the benefit of both the FAA and the industry if FAA established a directive specifying the procedures for submission of unsolicited R&D proposals, including the format and content of such proposals, and the procedures for FAA evaluation of such proposals and for FAA response to the offerer in a specified time period. In this regard, we recommend the establishment of funding to support projects awarded as a result of unsolicited proposals.

6. Improvements are Needed in Informing Industry of FAA Long-term R&D Needs

There is need for an improved, systematic means of communicating FAA long-term R&D needs to the industry. It is most probable that there is technology readily available, now or in the immediate future, within the electronics industry which could be applied to meet many of the long-term needs of FAA. However, these huge technology resources are not being tapped because of a general lack of industry awareness of these FAA needs. Consideration should be given to a systemized procedure whereby FAA could communicate its long-term needs to industry and other potential bidders much in the way that the military departments conduct Advance Planning Briefings for Industry (APBI's). This would be particularly helpful in the non-NAS plan R&D areas, at this time. It would also complement our recommendation in paragraph (6) regarding unsolicited proposals.

CONCLUSION

In conclusion, we would like to reiterate that these views are based on the FAA R&D process as perceived by industry. We recognize that FAA may have valid reasons for conducting its R&D as it does. To the extent that our views and FAA views conflict, we urge they be regarded as "honest differences" among two groups, both of whom are genuinely concerned with the need to maintain a modern and safe air traffic control system.

We are also encouraged by the reported FAA initiation of organization changes. In this regard, representatives of our Association would be willing to work closely with FAA representatives toward our common objectives.

Mr. GLICKMAN. Thank you very much. Dr. Fearnsides?

Dr. FEARNSIDES. Thank you, Mr. Chairman. I am going to highlight my testimony as well, and ask that a full copy be entered in the record.

I am a Vice President of the Mitre Corporation. In that capacity I direct the Corporation's activities in support of FAA and NASA. Before coming to Mitre, I served for seven years with the Department of Transportation, beginning as a manager of the Department's first advanced research program and eventually becoming the Department's Chief Scientist.

I have been watching FAA's R&D program one way or another since 1972. In my opening statement submitted for the record I have focused on operations research, kind of an interesting part of the new organization that the Administrator proposed, and I think it is an excellent start to solving some of the major problems that I heard this Committee ask Mr. Helms about and a major start in getting more R&D funding for FAA.

I think part of the problem now is that without maybe what Mr. Helms calls a "dynamic simulation," it wouldn't really have a connection between the R&D investment and the problems that they are intended to solve. Because of this, and it is a big undertaking, as Mr. Helms—and probably I would suspect even bigger than Mr. Helms—suggested, $4.6 million, I think, would barely get us under way. I think that without such a framework that would, for example, exist in AT&T, the kinds of tools that Bell Labs has to support that operation—without those kinds of tools it is very difficult to put R&D planning and R&D investment strategies on a quantitative basis.

Almost all of the questions that were asked of Mr. Helms and the questions this Committee asks year after year are questions that can't be answered because of the absence of a quantitative framework. These are not impossible to do.

As a consequence, and without such tools, the R&D program manager is very often faced with spending half of his money on justifications, half of his money on salesmanship and not really having the kinds of tools that he or she needs to convince the Committee, or convince anybody for that matter, what R&D needs doing.

There is a lot of FAA-bashing that kind of goes on, as far as R&D and the like, but the fact of the matter is that it's process—budget process, OMB process that is often the problem. I think the best way that I can give you to indicate some of the elements of this process is what happened with me when I came out of Bell Labs to begin the Department's first advanced research program. I was lured away with the prospects of running a multi-million dollar advanced research project. By the time I signed on, it was $700,000 and I was told at the time that I needed a cost benefits study for each one of the projects that I should start. Well, a cost benefits study without the kind of a dynamic simulation or without a kind of an understanding of what the operation really needs and what kind of problems you can foresee, a cost benefits study usually involves a lot of guesswork on the part of the R&D program manager. But the program manager goes forward and dutifully does his job and then his assumptions are ridiculed. So it is a Catch-22 situ-

ation. The process is the reason that R&D isn't bigger in my mind than it should be with FAA, and given its enormous operational and safety responsibilities, my feeling is that strong support of an operational research capability will be the next step to a significantly increased, more justified R&D program.

[The prepared statement of Dr. Fearnsides follows:]

STATEMENT OF DR. JOHN J. FEARNSIDES

VICE PRESIDENT

CIVIL SYSTEMS DIVISION

THE MITRE CORPORATION

BEFORE THE SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

OVERSIGHT HEARING TO REVIEW THE ACCOMPLISHMENTS

OF FY88 AND PLANS FOR FY89 RESEARCH AND DEVELOPMENT

IN THE FEDERAL AVIATION ADMINISTRATION

MAY 3, 1988

Good afternoon Mr. Chairman. I am Jack Fearnsides and am Vice President of The MITRE Corporation. In that capacity I direct the Corporation's activities with the FAA and with NASA. In a prior existence I served for seven years with the U.S. Department of Transportation beginning as the Manager of the Department's first advanced research program and eventually becoming the Deputy Undersecretary, Chief Scientist, and Acting Assistant Secretary for Policy and International Affairs. In one capacity or another, I have been observing FAA's R&D program since 1972. My views are my own and are not necessarily the views of the MITRE Corporation.

Mr. Chairman, it is my view that this hearing, or at the latest the next hearing, should be the last one at which FAA's R&D budget justifications are presented on a qualitative rather than a quantitative, basis. The factors underlying this change are (1) the beginning of the development of a set of tools that I will characterize as operational research and (2) the institutionalizing of the use of these tools in agency decision making processes. These are recent initiatives of Administrator McArtor and I strongly endorse them. This use of operators research tools has the potential to put agency decision making, including R&D investment decision-making, on a more businesslike basis.

Before proceeding with a fuller explanation of how operations research can be applied to R&D planning, I want to make it clear that the planned application of such tools does not imply that prior (or current) arguments for R&D budgets before this Committee have been inappropriate. Indeed, this improved basis for R&D decision-making has only come about because of a set of external influences on the entire FAA mission, of which R&D is, obviously, only a part. In the rest of this statement I will address two questions: "What benefits can we expect from the use of operations research into R&D investment decisions?" and "Why hasn't it been used before?"

Operations research, as a discipline, has been around since World War II. The term operations research has, in the intervening years, come to imply a set of analytic tools that (1) simulate a particular operation, (2) estimate the performance of that operation, (3) assess the cost of conducting the operation, (4) calculate the capital and personnel required to perform the operation, and (5) evaluate the potential benefits of new technology. There are also operations research-related tools that enable the analysis of investment decision making (e.g., R&D) alternatives.

The FAA is now funding the development of a computer model of the nation's airport/airspace system. By the end of FY88 there should be in place the capability to estimate the capacity of this system and to identify bottlenecks that occur at airports or in sections of the airspace as demand grows. This tool will therefore support both FAA's airport planning functions and the development of air traffic controller staffing profiles. It will also be able to be used to optimize the routing of aircraft as, e.g., bad weather closes parts of the airspace.

This computer model will also be used to analyze the performance of the airport/airspace system over some planning horizon by using forecasted traffic levels as inputs. This is important for this Committee because it provides an improved basis for R&D investments; i.e., it identifies predicted system problems that the R&D products must address.

But R&D planning should not be driven solely by predicted operational problems. There are also opportunities for improving system performance and/or costs by the exploitation of new technologies. There are many, for example, who believe that the communications, navigation, and surveillance functions of ATC can be performed by a satellite-based rather than ground-based system. Operations research can be used to evaluate the performance and (life cycle) cost characteristics that the new technology must possess before being introduced into operation. An interesting non-ATC example is the transition of long-line telephone transmission facilities from coaxial cable to satellite to fiber optic cables.

Why haven't operations research tools been used to support FAA decision-making in the past? I think there are two main reasons. First, prior to deregulation, airspace capacity could be considered infinite for all intents and purposes. The main job of the FAA was (and is) separation assurance. Since deregulation, however, the FAA has had the important extra duty of managing the flow of air traffic in a way that maximizes the utilization of the airspace resource. This requires operations research tools. The application of those tools to R&D planning is, therefore, somewhat of a bonus.

The second reason that a more quantitative basis for R&D budget requests hasn't been developed heretofore is, that it is rare that Congress or OMB allocates budgets for this purpose. It is hard to ask someone to do an analysis of the benefits of implementing a particular technology if he has few resources and no in-house national model to perform analyses on. Depending on the state of development of a particular technology, it may be very hard to predict just how much performance can be wrung from it. This means that some prototyping must be done to get a better estimate of the effects of new technological applications. But suppose the prototyping shows that the original idea would not produce the desired system improvement? The Program Manager is considered a failure and criticized for asking for the money in the first place. This dynamic assures that no Program Manager will ever admit that the experiment should be cancelled. In turn, this means that the Program Manager doesn't want to have some analytical model available that could show the likely shortcomings of the technological initiative.

What does all of this mean for the deliberations of this Committee, Mr. Chairman? First, I think it means that the Committee should be generous in its support of Administrator McArtor's operations research initiative. As a quod pro quo for this generosity the Committee should expect a much greater level of substantiation for R,E&D budget requests as the development of these tools are completed. Secondly, the Committee ought to let it be known that it understands that R&D is the less

conservative part of the agency's investment portfolio. There will be risks but, with proper management, the payoffs can be substantial.

Mr. Chairman, my emphasis on operations research is provided only to help your exploration of the implications of this new phenomenon for FAA R&D. I recognize that it is but one of the many considerations before this panel and I will be happy to answer any questions you may have.

Mr. GLICKMAN. Thank you very much. Dr. McFarland?

Dr. MCFARLAND. Mr. Chairman, Mr. Lewis, thank you for this opportunity to present my views here today. I am Richard McFarland, Director of the Avionics Engineering Center at Ohio University. That's a part of the academic department of Electrical and Computer Engineering. I am a registered professional engineer and earned my Ph.D. back in 1960. I am an FAA-certificated airline transport pilot. My purpose here is to make some statements based on my experience gained in working continuously with the FAA/CAA since 1957 in the context of providing R&D from a university base.

At Ohio University we have been in continuous contractual relationships with the FAA since 1962. To fulfill its mission successfully, the FAA must depend heavily on the products of technology. Historically the FAA, in my opinion, has not supported programs that develop basic technologies. A decade ago I heard an FAA associate administrator without apology state that the FAA was a small participant in developing new technologies and that they would depend on the military, the big spenders, so to speak, to produce the results and the FAA would use these.

To be able to use technology, one must be knowledgeable and to be knowledgeable one must be involved. FAA personnel need to be involved in the development of technologies which are to be applied to the nation's airspace in the future. In general, today they are not. The FAA is not now organized to encourage research and development.

It is worth noting, however, here today that there appears to be a plan under development now that may change that. Presently, their organizational structure does not even identify or recognize R&D as such.

On the positive side of the ledger, it is important to note that recently the FAA has taken some small steps to become involved in university R&D. Three years ago they joined NASA in a program that NASA had supported in air transportation technology for 14 years. This was a joint university program using the resources of MIT, Princeton University and Ohio University. This tri-university group has developed new ideas, evaluated contemporary ones. It has demonstrated that certain concepts can be useful in improving air transportation.

Well-trained students and technical results are dual benefits to the United States produced by this Government-university work effort. The program is small but is singular. More of this type of involvement with universities would be valuable because it could allow for longer-range R&D activity by the FAA. Presently, the R&D balance to me appears to be skewed much in favor of the short-range.

Some within the FAA view R&D outside with groups such as Ohio University to be competitive rather than complementary to the FAA in-house efforts. While these views are sometimes evident at the FAA Technical Center and in a few FAA regions, such views do not seem to be prevalent with Washington headquarters personnel, fortunately.

Unfortunately, the FAA is not aggressive in seeking ideas from the outside. The feeling inside the FAA seems to be that most

workers on the outside are not well enough informed concerning FAA-peculiar requirements such that their suggestions will be meaningful and applicable. My view is that with more communications with those outside the FAA, the FAA could substantially enhance meaningful input. FAA needs more involvement and contact with universities. This will enable them to draw from the national resources the best and newest ideas and to make these available for application to meet the nation's requirements for solving the problems of increasing needs for transporting people and materials quickly and efficiently.

There are many potential benefits to the FAA by having close relationships with universities. I strongly recommend that such relationships be developed and nurtured. Continuity is an important factor in working with the universities. With good relationships the universities will benefit too, and become stronger.

All of this will combine to produce a strong national technological capability for solving problems associated with air transportation. I am confident there will be well-educated and trained young people who can move the frontiers of technology ahead in the future.

In summary, I am convinced that implementation of action supporting this recommended action involving universities will have a threefold benefit. Specifically, FAA will get faster and better solutions to the technology problems; the nation's technology base will be enhanced; and future engineers working in Government and industry will be better prepared for their tasks.

I thank you for your consideration of this recommendation and for allowing me to express myself here today.

[The prepared statement of Dr. McFarland follows:]

STATEMENT BY RICHARD H. MCFARLAND, PH.D., OHIO UNIVERSITY

Thank you for the opportunity to present my views here today. I am Richard McFarland, Director of the Avionics Engineering Center and Professor of Electrical Engineering at Ohio University, Athens, OH. I am a Registered Professional Engineer in Ohio having earned my PH.D. in Electrical Engineering in 1960. I am an FAA-certificated Airline Transport Pilot. My purpose here is to make some statements based on my experience gained in working continuously with the FAA/CAA since 1957. At Ohio University we have had continuous contractual relationships with the FAA since 1962.

To fulfill its mission successfully the FAA must depend heavily on the products of technology. Historically the FAA has not supported programs that develop basic technologies. A decade ago I heard an FAA associate administrator without apology state that the FAA was a small participant in developing new techologies, and that they would depend on the military, the "big spenders", to produce the results and the FAA would use these.

To be able to use technology one must be knowledgeable, and to be knowledgeable one must be involved. FAA personnel need to be involved in the development of the technologies which are to be applied to the national airspace in the future. In general, today they are not.

The FAA is not now organized to encourage research and development. Their organizational stucture does not even identify or recognize R&D.

On the positive side of the ledger it is important to note that recently the FAA has taken some very small steps to become involved in R&D. Three years ago they joined NASA in supporting a Joint University Program in Air Transportation Technology. In this tri-university program which had been underway for 14 years, Ohio University in concert with MIT and Princeton University has developed new ideas, evaluated contemporary ones, and has demonstrated that certain concepts can be useful in improving air transportation. Well trained students and technical results are dual benefits to the United States produced by this government-university work effort. The program is small but is singular. More of this type of involvement with universities would be valuable because it could allow for longer range type R&D activity by the FAA. Presently the R&D balance to me appears to be skewed much in favor of the short range.

Some within the FAA view R&D research done outside with groups such as Ohio University to be competitive rather than complementary to FAA in-house efforts. While these

views are sometimes evident at the FAA Technical Center and a few FAA Regions, such views do not seem to be present with Washington Headquarters Personnel fortunately.

Unfortunately the FAA is not aggressive in seeking ideas from the outside. The feeling inside the FAA seems to be that most workers on the outside are not well enough informed concerning FAA-peculiar requirements such that suggestions will be meaningful and applicable. My view is that with more communications with those outside the FAA, the FAA could substantially enhance meaningful input.

FAA needs more involvement and contact with universities. This will enable them to draw from these national resources the best and newest ideas and to make these available for application to meet the nation's requirement for solving the problems of increasing needs for transporting people and materials quickly and efficiently.

There are many potential benefits to the FAA by having close relationships with universities. I strongly recommend that such relationships be developed. Continuity is an important factor. With good relationships universities will benefit, too, and become stronger. All of this will combine to produce a stronger national technological capability for solving problems associated with air transportation. Concomitant will be well-educated and trained young people who can move the frontiers ahead in the future.

In summary, I am convinced that implementation of action supporting this recommended action of involving universities more will have a three-fold benefit, specifically, FAA will get faster and better solutions to their technology problems, the nation's technology base will be enhanced, and future engineers working in government and industry will be better prepared for their tasks.

I thank you for your consideration of this recommendation and for allowing me to express myself here today.

Mr. GLICKMAN. Thank you very much. Ms. Page?

Ms. PAGE. Thank you, Mr. Chairman. It's a pleasure to appear before this Subcommittee today. I have been the Project Director for a recently completed study by the Office of Technology Assessment of Aviation Safety. The study is currently in press. We expect that it will be released in late May. Today, I will share with you some of the work that we have done related to R&D.

I feel a little bit as though I should be a spokesperson for NASA after listening to these distinguished folks, gentlemen, speak for each of the other segments of the research community. However, rather than speaking for a single organization or type of research, I will address the generic problems or situation with FAA R&D that we examined as we worked through our project.

We found that FAA's technology development programs could benefit from increased funding, from additional emphasis on the interaction between humans and equipment, and from some changes in emphasis. For example, the technology development programs often do not match the near term needs of the air transportation system.

There are a number of reasons for this. It's partly a function of the fact that much of FAA focuses on day to day operations to the exclusion of either long or short term planning, and it also stems from the undeniable difficulty of anticipating the needs of a system so subject to changes in airline schedules and operations. These are changes made by industry completely independent of FAA. The government's inefficient, inflexible technology development and procurement system compounds these obstacles.

In general, however, we would say that FAA is badly in need of analytical models for predicting system problems. We have heard some other people address that this afternoon.

We're trying out solutions such as systematic planning for R&D, and early operational testing programs. Moreover, in all areas of R&D, whether performed by the government or private industry, the FAA needs expertise that government pay scales cannot guarantee. Because of personnel and budget constraints, FAA relies heavily on its contractors, both for defining program requirements and for actually developing technologies. The Technical Center does evaluate contractor technology. However, government salary scales usually preclude hiring personnel with technical qualifications as high as those of the government contractors. Under these circumstances, ensuring adequate technical and analytical quality control of government projects is very difficult.

A fundamental impediment to R&D reform for all FAA systems is the rigid procurement process, a problem in other agencies as well. This process encourages FAA managers to lock into long term development projects with milestones that extend years into the future, and to view suggestions for change as obstacles in meeting those milestones. This means that technologies eventually produced by the technical branch of FAA may not be readily accepted by the operating branch of FAA, whose needs may have altered substantially in the interim. Thus, those involved in developing R&D projects are sometimes not only unreceptive to ideas generated outside FAA, they may well be unreceptive to ideas from within.

OTA identified several changes that might improve matters. First, the compensation scale for some FAA personnel could be increased to permit higher and better technical expertise. Second, the R&D and procurement processes could be revamped to encourage early operational testing of alternative approaches and rapid fielding of the most suitable and successful technologies. Third, FAA's recent emphasis on developing quantitative models and analysis techniques for identifying system needs would be made an ongoing program extending beyond changes in administrators which often bring an end to newly initiated programs.

OTA identified human factors as an area of R&D that needs more emphasis at FAA. Such research is essential to the safe design and operation of any complex system. Human performance concerns regarding cockpit automation, pilot selection and training, and airline management are not addressed adequately. Congress may wish to consider increasing support for R&D in this vital area.

You could regard my testimony, Mr. Chairman, as a series of challenges. Is it possible to reframe the context in which R&D for aviation is carried out so as to overcome some of the difficulties we have heard discussed today? OTA is pleased to have identified some approaches to tackling the challenges and stands ready to assist as appropriate.

Thank you.

[The prepared statement of Ms. Page follows:]

STATEMENT OF EDITH B. PAGE
Project Director
Office of Technology Assessment

Testimony Before the
Subcommittee on Transportation,
Aviation, and Materials
Committee on Science, Space, and Technology
U.S. House of Representatives

FAA'S RESEARCH AND DEVELOPMENT PROGRAMS

May 3, 1988

FAA'S RESEARCH AND DEVELOPMENT PROGRAMS

Good afternoon. It is a pleasure to appear before the Subcommittee to discuss aviation research and development (R&D). The Office of Technology Assessment has recently completed a study of air safety entitled Safe Skies for Tomorrow: Aviation Safety in a Competitive Environment. The study is currently in press, and we expect to release it in late May. Prepared at the request of the House Committee on Public Works and Transportation, the study considers Federal safety standards and programs and changes in the aviation industry since economic deregulation. FAA's technology and R&D programs were among those that OTA reviewed. I will share with you some of the results of our work.

OTA found that the Federal Aviation Administration's (FAA) technology development programs could benefit from increased funding, from additional emphasis on human factors, and from some changes in emphasis. For example, FAA technology development programs often do not match the near-term needs of the air transportation system. This problem is partly a function of FAA's focus on day to day operations to the exclusion of systematic planning, either long or short term. It also stems from the undeniable difficulty of anticipating the needs of a system so subject to changes in scheduling and operational decisions — changes made by industry independently of FAA. The inefficient, inflexible technology development and procurement system that is endemic to the Federal Government compounds these obstacles.

In general, the agency is badly in need of analytical models for predicting system problems and for trying out solutions, of systematic planning for R&D, and of early operational testing programs. Moreover, in all areas of R&D, whether performed by the government or by private industry, the FAA needs expertise that government pay scales cannot guarantee.

Because of personnel and budget constraints, FAA relies heavily on its contractors both for defining program requirements and for actually developing the technology. FAA's Technical Center in Atlantic City is involved with test and evaluation of contractors' technology, at the behest of FAA Headquarters in Washington. While this arrangement is not inherently a problem, government salary scales do not always permit FAA to hire personnel with technical qualifications as high as those of its contractors. Under these circumstances, ensuring adequate technical and analytical quality control of government projects is difficult. OTA concluded that it is important for FAA to have in-house expertise sufficient to demand the highest standards and use of the latest technologies by contractors.

A fundamental impediment to R&D reform for all FAA systems is the rigid procurement process, a problem in other agencies as well. The process encourages FAA managers to lock into long-term development projects with milestones extending years into the future, and to view any suggestions for change as obstacles to meeting milestones. Requirements for projects are sometimes developed with insufficient connection to real operating problems, often because inadequate attention has been paid to needs of the end users. This means that technologies produced by the technical branch of FAA may not be readily accepted by the operating branch of FAA. Thus, those involved in developing R&D projects are sometimes not only unreceptive to ideas generated outside FAA; they may well be unreceptive to ideas from within! The requirement that air traffic staff coordinate and cooperate in the development of the Advanced Automation System plays a small, but important role in overcoming these attitudes.

OTA identified several changes that could improve matters. First, the compensation for some FAA personnel could be increased to allow FAA to hire better technical expertise. Such expertise is needed regardless of whether FAA does the R&D itself or has a contractor do it. Second, the R&D and procurement processes could be

revamped to encourage early operational testing of alternative approaches to solve problems, and rapid fielding of the most suitable and successful technologies. This would mean better exchange of needs and suggestions between technology staff and operations staff, as well as a facility in which options could be tried. (Incidentally, this is one of the Packard commission's recommendations for DOD, too.) This does not mean that longer-term development should be ignored; only that reliance on a long-term program without sensitivity to users' current and ongoing needs can lead to obsolescence. Third, FAA's recent emphasis on developing quantitative models and analysis techniques for identifying system needs is well worth continuing and making an ongoing program, even through changes in Administrators.

OTA identified human factors as an area of R&D that needs more emphasis at FAA. Such research is essential to the safe design and operation of any complex system. Aircraft are no exception, and human errors contribute to the majority of aviation accidents. However, human error hazard analyses are not presently a normal part of aircraft system design or certification. While many Federal Aviation Regulations deal directly or indirectly with human performance, few of them are based on scientific evidence. Human performance concerns regarding cockpit automation, pilot selection and training, and airline management are not addressed adequately. Congress may wish to consider increasing support for R&D in this vital area.

TYPES OF R&D

FAA R&D generally falls into three categories: work in support of the National Airspace System, for air traffic controllers, and a small amount for regulatory programs. For purposes of convenience, each of the three categories will be discussed separately.

The National Airspace System

FAA's plan to upgrade the National Airspace System has suffered delays and cost overruns for some of the reasons given above. Unfortunately, however, the magnitudes of these problems with the NAS Plan projects are not unusual for large, complex government development programs. Changing system requirements and software difficulties, coupled with inefficient, inflexible technology development, are the basic difficulties. While in principle FAA has sufficient operational data to project system needs in practice it has limited capabilities for using the data to identify needs, and limited means to develop and evaluate alternatives for meeting them.

For example, OTA concluded that the nation's Air Traffic Control (ATC) system is already under stress from increases in traffic levels and bunching of demand, a byproduct of hub and spoke operations. We have every reason to expect continued traffic growth in coming years, and OTA concluded that rapidly increasing demand could outstrip the capabilities of portions of the ATC system.

FAA's planned upgrade of the system, the Advanced Automation System, is not expected to be ready until at least the mid-1990s. To provide more immediate relief, FAA has recently added an interim ATC support program to its plans. For this program to be successful, FAA must be able to anticipate problems, hypothesize solutions, and develop and evaluate alternatives. Technologies, personnel needs, and procedures must all be considered. Moreover, decisions on changes in the ATC system must be made in a relatively short time, or air transportation will suffer, and the solution may be obsolete by the time it is implemented. R&D to identify and predict ATC safety and capacity problems, and allow testing of alternatives under simulated operating conditions, is needed to facilitate rapid, innovative solutions to ATC problems. Steady and comprehensive input from air traffic controllers from the earliest stages is crucial. FAA's capabilities in these areas are limited.

Air Traffic Control

FAA does R&D on air traffic controller selection, training and performance at the Civil Aeromedical Institute, or CAMI, in Oklahoma City. Most of the selection and performance research is focused on the near term, although some attention is directed to the controller in the longer term, when automation features will be introduced. The human/computer interface and the effects of automation are major questions for the future, and a greater emphasis on developing expertise in these areas would prepare FAA for evaluation of new air traffic control technology.

Aviation Standards

OTA concluded that FAA needs significant increases in R&D to support development of safety regulations for aircraft and aircraft operations. Much of the current R&D is done at the Technical Center in Atlantic City, particularly in aircraft crashworthiness and fire safety. However, NASA also does some work, in aircraft icing and human factors, for example. In theory, NASA does basic R&D, while FAA concentrates on applied R&D. However, in practice, work done by NASA is not always recognized or applied by FAA in its standard setting processes.

FAA has not devoted the same level of resources to research in cockpit human factors as it has for human performance in ATC, or provided sufficient qualified staff to understand and synthesize findings from NASA, industry, DoD, and universities. While FAA, as a regulatory agency, might not be expected to conduct much research in-house, it must serve as a catalyst and coordinator for aircrew human performance research. FAA's Cockpit Human Factors Research Plan in 1985 (developed by Transportation Systems Center) proposed a number of important projects; however, few received sufficient funding. The Joint Government/Industry Task Force, formed last year to identify air crew performance issues, review existing regulations on training, and make policy recommendations, is a step in recognizing this neglect. However, OTA concluded

that without top level insistence on systematic attention to this important area of R&D, human factors will not receive sufficient emphasis.

Industry has its own aircraft technology development programs, and FAA is hard-pressed to keep up. FAA has ten or so National Resource Specialists in a set of technical areas who can be paid more than FAA engineers. However, this is too small a number of experts to be an effective resource for FAA in evaluating advanced technologies.

This testimony could be viewed as a set of challenges, Mr. Chairman, for Congress, for FAA, and for the government as a whole. Is it possible to reframe the context in which R&D for aviation is carried out so as to overcome some of the difficulties we have heard discussed today? OTA is pleased to have participated in identifying some of the measures that could be considered in tackling the challenges, and stands ready to assist as appropriate. Thank you.

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AVIATION STANDRADS
NATIONAL RESOURCE SPECIALISTS

Name	Specialty
Walter Korsgaard	Explosives
Thomas Imrich	Operational Evaluation/ Test Piloting (Air Carrier Operations)
Richard Adams	Aircraft Icing
Terence Barnes	Flight Loads/Aero-elasticity (Fixed Wing)
Michael DeWalt	Aircraft Computer Software (Engineering)
George Lyddane	Flight Management
Joseph Soderquist	Advanced Materials/ Nonmetallic
Stephen Soltis	Crash Dynamics
Thomas Swift	Fracture Mechanics/ Metallurgy
James Treacy	Advanced Avionics/ Electrical

Mr. GLICKMAN. Thank you all for excellent testimony. Let me ask you all something. You know the proposal to separate the FAA from the Department of Transportation, in some way, is guided by the fact that the folks who proposed that, felt that it should not be operated under many of the government restrictions.

Like, for example, compensation restrictions. How would you see that doing that, accomplishing that legislatively, pulling the FAA out in some form from the Department of Transportation, would affect its ability to do research?

Dr. FEARNSIDES. Mr. Chairman, my understanding from what I've learned recently from the Aviation Safety Commission Report is that Congress, in setting up an independent agency, has more or less the purview, the right, to establish personnel policy, procurement policy.

To give you two examples, I remember that when NASA was formed, there was a great emphasis on bringing highly qualified science technology people into NASA and they had Public Law 313 as I remember it where people of accomplished scientific or technical ability could be brought in without going through the usual OPM process. And there was also the case in the formation of the Department of Energy during the time of the national energy crisis when the procurement approaches that the Department of Energy was allowed to use were more streamlined.

I think that one of the difficulties, obviously, with the whole notion of transferring FAA out from DOT, is whether or not you have to solve the whole set of Federal problems in order to do that. And I would say that if you have to do that, you probably ought to concentrate on ways of doing that inside rather than outside.

The FAA is an operational agency. It truly has different roles to play than many other Federal agencies, and the same kinds of—and especially now in the rapidly changing environment, the post-deregulation environment I think not only—the administrator needs tools whether—and to the extent that bureaucracies everywhere impede those tools, his job is much more difficult.

Ms. PAGE. Would you like me to address that also, Mr. Chairman?

Mr. GLICKMAN. Yes.

Ms. PAGE. Our work indicated that the exact placement of FAA within the governmental structure was less important than resolving these issues of personnel and pay scales. If there can be a way found, and there would probably be legislation required, to resolve these problems and still keep FAA as an operational agency within DOT, there would be some benefits to that.

The technical expertise that does reside at FAA is absolutely essential in making—as background for making—many of the decisions that DOT has to make on access to the air system and so on. But the political sensitivity that DOT on occasion brings to the process, that Congress always brings to the process, is also a very integral part of making those decisions. And that is a tradeoff, it has to be weighed in separating the FAA from DOT. You asked, really, basically, whether there was a legislative way to provide for these needs FAA has for R&D, and I would think that it would be important to try to explore all those ways.

Additional legislation to permit hiring more national resource specialists is one example. Providing FAA with the ability to make some of the procurement decisions in ways that NASA and DOD have done. Experimenting with parts of the system where the problems reside, rather than moving the whole agency, is one avenue that should be explored.

Mr. GLICKMAN. Well, one of the experiences I've had with visiting both the FAA technical facility and the NASA facilities is that, in fact, and it goes to a little point you raised about cockpit research and human factors, is that over the years, the FAA has not really focused on, if it's an operational agency, then you'd think their research would be in the operational end of the picture, and it has not been in the operational end of the picture.

To the extent that there's been operational research curiously, it's come from NASA, in the government. And NASA is probably not equipped to focus their research as much as the FAA is because they're not dealing with as many—they're dealing with more abstract problems. And, so, what ends up happening in my judgment is a lot of the research that NASA has done, the operational stuff, is kind of repetitive, continuous from year to year, nothing really ever happens to it, or it doesn't end, it doesn't begin, it doesn't have any crystallization to it. Where, if it were being done over in the FAA, adequately funded, it might have some focus to it.

Ms. PAGE. We address that issue specifically in our work because we—you're precisely right, the work that NASA does is more germane, but it never gets translated into any of the aviation standards work. And we identified that as a specific need.

We also know from our conversations with the people at CAMI that they have a list of human factors, operational research projects, that they would like to see ongoing, many of them addressing these operational problems. But for one reason or another, and it fundamentally comes down to the fact that the aviation standards group where these operational standards are set, and where the research should be used, has simply never had a genuine interest in pursuing this.

Mr. GLICKMAN. For example, the human factors research for aviation in our government is done primarily in NASA.

Ms. PAGE. That's correct.

Mr. GLICKMAN. Why? It doesn't make any sense. Why would it not at least have—why wouldn't the programs be jointly run—because after all, it's not NASA that's running the agency that is supervising airplanes flying in this country that run out of gas, where the problems occur, or, you know, flaps being put down and all this kind of stuff.

Dr. Fearnsides?

Dr. FEARNSIDES. I think that we may have a problem of the definition of operations here. To the FAA, first of all, I think a good bit of the cockpit technology has always assumed to be the province of NASA, although there has been interaction.

But, to the FAA as well, operations is what the controller does. There is a ferocious and substantial operations, or human factors, research job that needs to be done when you think of the new functions that the controller with a new set of displays in front of him,

multiple displays instead of a single display as he has now, is going to have to deal with.

What deregulation has done is to change the basic mission of the FAA from merely one of separating airplanes in a more or less semi-infinite air space to one of managing the traffic in the air space, as well as keeping them apart.

This is an important—it's like a company getting a major—change in its market. It's like Detroit being faced with Japanese cars. It's a major change. The NAS plan will give us the capability to do this, but there is an enormous amount of work that needs to be superimposed upon that to make the system be able to handle traffic management, better ways of doing terminal air traffic control, more applications of datalink as Mr. Helms mentioned, a better approach to oceanic air traffic control. There are all kinds of new functions that have occurred primarily as a result of deregulation that have got to be laid on top of that NAS plan.

One of the questions that I heard earlier is why does the FAA spend so much time on air traffic control research, and the answer is, it's a big problem and they're responsible for it.

Now, as the—one of the things that we're noticing and one of the things that will develop over the upcoming years, is the fact that the aircraft flying in that air traffic control system are going to be smarter and be a much more viable interactive part of the air traffic control system.

Mr. Helms' program, TCAS, started that. He mentioned a couple of other applications of TCAS type environments, station keeping in a terminal environment, let's take the notion of how we take wind shear information up.

Do we really have to cycle this through the air traffic control—through an air traffic controller, or can we datalink that up in the interest of time.

Shouldn't we have pilots giving weather information that in some kind of a real kind of command and control system could be distributed and give us much better ideas——

Mr. GLICKMAN. Who should be doing all this?

Dr. FEARNSIDES. The FAA should be doing——

Mr. GLICKMAN. Yes.

Dr. FEARNSIDES [continuing]. Most of it, and there's not enough funding to do that.

Mr. GLICKMAN. I want to ask you all a question. I talked a little bit about geriatric airplanes. That's an operational problem, that's the operational problem that's the life or death issue to all of us.

These airplanes that were built 20 years ago, are they suitable to be flying today? Who is or should be doing research on metal fatigue in airplanes.

Ms. PAGE. Mr. Chairman, that activity has historically been, as Dr. Fearnsides said, the province of the industry. I would say that you correctly identified all of the human factors research that needs to be done for air traffic and I don't question that at all. There is, however, some attention being paid to that in the FAA.

There is virtually none, Mr. Chairman, being paid to the operations of the airlines and the certification processes for the airlines. The reason is that we are faced, now, with a whole new set of problems, and there has never been an interest or intention in the

aviation standards part of FAA to develop the expertise necessary to evaluate this because it has historically been the province of the manufacturers of the aircraft. And Boeing and McDonnell Douglas do spend a great deal of money on that research.

Mr. GLICKMAN. But we never anticipated flying airplanes like we're flying them right now.

Ms. PAGE. Correct. And Boeing—the manufacturers are very concerned about this. The OTA felt that one of the results of our work was that the aviation standards section (in which the certification and the training standards, all of the regulations that apply to the operations of the industry), that it desperately needed to pay more attention to human factors, and to the issues associated with certification.

It is in that area of certification that we were particularly concerned about the constrained resources. In our visits to the FAA facilities, we were told that they were suffering because they could not make offers that were acceptable to the engineers who had to do the certification activities for the aircraft, that the engineers would accept the salaries for industry that simply were sufficiently higher than the ones FAA could offer, that they could not get expert technical help.

Mr. GLICKMAN. You know, we faced some of the same problem after the Air Florida crash. You had obviously a series of operational problems, suitability of pilots, weather, and it came down to a very interesting thing. We talked about de-icing, the nature of the de-icing solution, and there we talked about what research had been done on modernizing and updating the glycol or whatever kind of solution that's used to de-ice airplanes. The general answer was: nothing since the 1930's, that the research had been focused in on, maybe kind of, on the side of the human factors of the repetitiveness of doing the de-icing itself.

And what de-icing research was being done was being done exclusively at NASA for all practical purposes. While there's some interesting work that was being done there, it wasn't very operationally oriented towards the way people are flying today.

Now, I don't want to get back into the bag of basic versus applied research because I know you need them both. But I'm saying that we are flying airplanes differently today than we were, and that we have our system, our research system based upon. So we had better move quickly to do more of the kind of research that hopefully Mr. McArtor is talking about doing now. Otherwise, we could find ourselves in a situation where we have failed to avert catastrophes, that have to do with the way we operate our system now. And that, I think, is the biggest failure of the FAA's R&D budget. I think it can probably handle a TCAS and the electronics part of the situation in moving airplanes around from an abstract point of view. I don't know if they do the necessary work on the human side, how humans interact with all of that.

But, while we're in this transition phase until hopefully Boeing and McDonnell Douglas build a whole new series of aircraft that are floating around in our skies, and we have the competent assortment of crew to run those planes, we've got real problems in this country for the next 15 or 20 years.

I think this Aloha accident is just the tip of the iceberg. That we're going to face, and it's going to be—and, in the same way that we have crash programs, operational programs, to take care of problems, it looks to me like we need some crash operational research programs to deal with the flying public's safety over the next 15 to 20 years.

Dr. FEARNSIDES. Mr. Chairman, I'd like to just bring up a point that having spent a lot of time working both with NASA and the FAA, that NASA in its inception has always been thought of as a research and technology function, having a strong research and technology function. R&D, or development and research, drives a good bit of what NASA is all about. They have an Ames Research Center, they have a Lewis Research Center, they have a Langley Research Center, enormous capabilities, enormous assets devoted to the conduct of R&D.

I think that every time there's a new administrator appointed, somebody gets to him and says, now, remember FAA doesn't do R&D. There is a mini-scale budget. It's burdened by doing, for example, design competition phases of ongoing acquisitions. There's not a heck of a lot left to do a lot of the things that people are asking to be done.

Mr. GLICKMAN. Well, maybe then we ought to have a merged department of NASA and FAA, then. You know, that's been discussed before, as well.

Ms. PAGE. It certainly would be helpful, Mr. Chairman, if I may interject, to have the FAA somewhat more receptive to using the resources that NASA has. If, for example, the aviation standards section were to identify some of these human factors, needs for development of operational regulations related to training and cockpit resource management, that sort of thing, that they could develop under FAA supervision, or with FAA management, a program that would incorporate the expertise that does exist, some at Ohio State, some at the University of Miami, at NASA. Taking advantage of existing expertise in this area, under FAA directive, could be a way to use those resources to their maximum.

But unless FAA takes the initiative and says, this is something we're interested in and we're going to pay attention to, that's not going to happen.

Mr. GLICKMAN. All right. Well, we appreciate very much your coming here today. These are very important issues and they're not abstract ones, they are real, serious, day to day issues.

Your statements will appear in the record in their entirety. Tomorrow, I believe, we meet again at 2:30. The Administrator will be here tomorrow.

Anyway, the hearing is adjourned for today.

[Whereupon, at 3:55 p.m., the Subcommittee recessed, to reconvene at the call of the Chair.]

FAA R&D PROGRAM REVIEW, NAS PLAN, CAMI MISSION, AND PROGRAM PLAN

WEDNESDAY, MAY 4, 1988

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS,

Washington, DC.

The subcommittee met, pursuant to notice, at 3:05 p.m., in room 2325, Rayburn House Office Building, Hon. Dave McCurdy (chairman of the subcommittee) presiding.

Mr. MCCURDY. The Subcommittee will come to order.

Mr. McArtor, we apologize. I'm not sure this bodes well for the NAS system, considering the computer just went down on the voting machine for members, and regardless of how you voted, it lighted up a little differently up there, and I am sure some of us felt as confused as some of the controllers out there with the 595 members that were recorded, and that is certainly one for the record books. It's going to be a slower afternoon, so perhaps we can get well in to the hearing without too much disruption.

Today the Subcommittee welcomes Administrator McArtor and his associates to the continuation of our FAA Research and Development Oversight Hearings. We are taking a different direction in our oversight hearings this year. Rather than examine specific programs, we want to look at the allocation of emphasis in FAA's R&D. Although we've planned this approach for many weeks, the recent incidents with Aloha and United underscore the need for our inquiry.

If we are to improve our safety record as reflected in these kinds of accidents, we must focus more of our research effort outside the air traffic control system. Such efforts have lagged in recent years as FAA R&D money has gone toward the NAS plan, an effort of vital necessity to be sure, but not an effort to replace work in other areas.

FAA reorganization is also on everyone's mind these days here in Washington and, I must admit, also in Oklahoma City, as we have discussed. FAA is reorganizing internally while at the same time reorganization proposals are debated in the halls of Congress. I want to be sure that we don't get lost amid all these reorganizations. Each of us is capable of criticizing the FAA, and indeed there is room for improvement, but we must be sure that we don't reorganize to the detriment of the agency that has given us all the safest aviation system in the world.

So while others propose, debate and execute reorganizations, we intend to be sure that the work goes on. We welcome you here today, Mr. McArtor. While we may not agree with everything you are doing, you have certainly been an active administrator during your short tenure and not one to duck the many challenges faced by aviation today.

We look forward to hearing your statement, and as you know we have a number of questions for you. At this point I will recognize the distinguished ranking member from Florida, Mr. Lewis.

Mr. LEWIS. Thank you, Mr. Chairman, and welcome, Mr. McArtor. I am happy to see you again and your colleagues. I am becoming increasingly convinced that the future advances in our safety will come only as the result of an aggressive long term research program.

Several of yesterday's witnesses agreed. Yesterday's witnesses stated that FAA is not now organized to encourage research and development and an FAA R&D program today is not meeting the nation's needs, that a formal long range R&D program should be developed by the FAA and that FAA needs significant increases in R&D to support development of safety regulations for aircraft and aircraft operations.

Yesterday I asked the question could the Aloha Airlines accident involving the top of a 737 blowing off been prevented. Is it possible to conduct a long range research program on predicting such catastrophes before they occur, and should FAA undertake such a research program?

Your press conference this morning brought out the problem of cold bonding and could this have been detected, and should FAA conduct an aggressive research program on detecting problems of this nature. I look forward to hearing your views on these other areas.

Thank you, Mr. Chairman.

Mr. MCCURDY. The gentleman from Kansas.

Mr. GLICKMAN. Thank you, Mr. Chairman. I just wanted to make one point, Mr. McArtor. In addition to your statement, which I have read and it is very good, I would appreciate your commenting on the FAA conducting an operational research program dealing with structural fatigue, wear and tear, and damage as a result of age and utilization of aircraft, particularly taking into account how we use airplanes now, not how they were designed 20 years ago, but how they are used as the result of deregulation.

I applaud your statement today on your expanding your airworthiness directive. I would also be interested to know whether maybe you are being not quite conservative enough and maybe other airplanes besides older 737s ought to be subject to this kind of inspection and review, so I appreciate the Chairman letting me make those comments.

Mr. MCCURDY. I thank the gentleman, and I think it is safe to say that the Subcommittee does appreciate the action that you have taken in your statement today and we look forward to your expanding upon the statement you made earlier today regarding the recent accidents, and at this point your entire statement will be admitted in its entirety into the record and feel free to expand upon that or summarize, however you wish.

Mr. McArtor?

STATEMENT OF HON. T. ALLAN McARTOR, ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION, ACCOMPANIED BY ANTHONY BRODERICK, ASSOCIATE ADMINISTRATOR FOR AVIATION STANDARDS, NEAL BLAKE, DEPUTY ASSOCIATE ADMINISTRATOR FOR ADVANCED DESIGN AND MANAGEMENT CONTROL, AND EDWIN S. HARRIS, ASSOCIATE ADMINISTRATOR FOR DEVELOPMENT AND LOGISTICS

Mr. McARTOR. Thank you, Mr. Chairman, Members of the Subcommittee. It is indeed a pleasure and an honor to appear before you today to discuss the FAA's research, engineering and development programs and the philosophies behind these programs. I welcome the opportunity to discuss those things with you.

I would like to have the statement entered into the record if I may, and to simply say that we in the FAA very much appreciate the support of this Subcommittee and of you personally in our efforts to modernize our Air Traffic Control System and to recapitalize our infrastructure with advanced technologies and to encourage the FAA to develop new concepts as well.

I might also say that I have been very much encouraged by the Agency's willingness, the energy and the competency of the FAA in recognizing the need as part of our Impact '88 program to make the Agency more effective. The theme is that we are trying to make ourselves as modern as the equipment that we are procuring and designing and we have many initiatives underway to do just that.

As part of this self-modernization program are some organizational changes which provide the environment for change and modernization, although organizational change by itself seldom accomplishes anything other than to create an environment, as does funding. Funding by itself does not guarantee a good program, but it certainly creates a more healthy environment for it.

We have recognized the need in the FAA for a more concentrated research and development program. We are hopeful that we will be able to demonstrate even the legitimacy of the FAA's research and development program. Where the Department of Defense and NASA and some other agencies are recognized as requiring and even being obligated to have R&D, the FAA seems to still struggle in some parts of the Hill with demonstrating the requirement, even our obligation for healthy R&D programs.

We are, after all, managing several billion dollars of high technology. We are organized well to do that, although we are bolstering the organization with which to manage these programs. We are into a very aggressive implementation and maintenance program as well. We are concentrating some of our executive management on those roles and one of the challenges that we have this year is to try to create research, development, training and education programs that do not compete for the financial resources of operations. I think we all know that if that occurs, who normally loses in the process.

Additionally, we have to create an organization where research, development, training and education do not compete for the senior

management attention, the time of senior management and that it has its own dedicated leadership.

With that, I will be more than happy to answer any questions that you have.

[The prepared statement of the Hon. T. Allan McArtor follows:]

STATEMENT OF THE HONORABLE T. ALLAN McARTOR, FEDERAL AVIATION ADMINISTRATOR, BEFORE THE HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION, AVIATION, AND MATERIALS, CONCERNING THE FAA'S RESEARCH, ENGINEERING, AND DEVELOPMENT PROGRAMS. MAY 4, 1988.

Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to appear before the Subcommittee today to discuss the Federal Aviation Administration's Research, Engineering, and Development programs. The FAA appreciates the long-standing support this Subcommittee has provided for our R&D programs and for our efforts to modernize the Air Traffic Control System. These programs are key to the future safety and efficiency of our air transportation system.

Advanced Technology is, in fact, one of the eight major areas of my Impact 88 program on which we are working, and I am pleased to report we have made significant progress in this area. We have accelerated development of TCAS III, the upgraded collision-avoidance technology that will reduce the risk of mid-air collision. We are also taking a hard look at microwave landing systems. We need a better plan of transitioning from ILS to MLS. In the interim, we need to buy more ILS's and I have instructed the FAA to do so.

And, finally, we have moved aggressively to fill the gap between today's urgent need for new equipment and the installation of

tomorrow's systems. We have developed a transition plan which we call the Interim Support Plan, for near-term procurements to more quickly replace existing hardware and refurbish old technology.

FAA must begin planning for the next generation of aviation. Therefore, I have accelerated development of satellite-based, data-link navigational aids, because our technology still promotes ground-based solutions to air traffic control problems. Unless we aggressively move more toward air-based navigational control, I am worried we will miss major opportunities to improve the safety and efficiency of our air traffic control system. Technology also exists to simultaneously transmit that information through data-link to the controller with greater accuracy without voice, and faster than the current reliance on ground-based radar. The $155 million in the FY 1989 budget will help bridge the gap from today to the installation of core NAS Plan equipment coming on line in the '90's.

NATIONAL AIRSPACE SYSTEM PLAN

For fiscal year 1989, the FAA budget proposes $1.6 billion in capital funds, 44% above the fiscal year 1988 actual level, to continue NAS Plan procurements. Some of the more significant investments planned in FY 1989 are Long Range Radar, En Route

Doppler Weather Radar, Advanced Automation System, Terminal Doppler Weather Radar, and the new Interim Support Plan I just mentioned.

About 90% of the major projects in the NAS Plan are already under contract, and deliveries have begun on over 55%. Sixteen percent of all NAS Plan projects are complete.

One of the more significant NAS Plan achievements is the Host computer installation. The first Host computer system was commissioned in May 1987 at the Seattle Air Route Traffic Control Center. By the end of calendar year 1987, all 20 Host computer systems were delivered. Today, 17 are operational. The remaining sites will become operational by mid-June. This will mark the successful completion of the first phase of the implementation of the Advanced Automation System. The success of the Host computer system demonstrates clearly how industry and government can work together to make things happen. I am grateful to the Subcommittee for its valuable assistance in helping us achieve this significant milestone.

The Host computers are only part of the story of our ongoing efforts to keep pace with a rapidly evolving National Airspace System. We are in the process of developing a new generation of

advanced automation, installing new primary and secondary radar systems, and upgrading the weather services provided to pilots.

The first new airport surveillance radar, the ASR-9, will be commissioned in Huntsville, Alabama, at the end of July. The first Microwave Landing System was shipped to Lebanon, New Hampshire in April. Installations of MLS will continue thereafter at a rate of six systems per month.

The Advanced Automation System program, the cornerstone of the NAS Plan, has completed Preliminary Design Review and is moving ahead with the Design Competition Phase. The Acquisition Phase contract award is expected in July 1988. In addition to increasing system capacity, the higher levels of automation introduced through the AAS will allow more reliable and safer services to the users of the NAS. The AAS will include new controller work stations with state-of-the-art color displays, a new distributed computer network with architecture design which will permit technology insertion and capacity expansion, and new software that will require up to 1.5 million lines of code.

In the Voice Switching and Control System (VSCS) program, we are continuing our effort to develop the intercom, interphone, and air-to-ground communication and control functions and capabilities needed for ATC operations. Completion of factory acceptance testing is expected in April 1989, with prototype VSCS delivery to

the FAA Technical Center in May 1989. The production contract award is anticipated at the end of fiscal year 1989.

In our weather programs, we expect to award the production contract for Terminal Doppler Weather Radar in September 1988. Enhancements to NEXRAD software to improve weather detection, including icing detection and storm cross-section display, will be explored in fiscal year 1989.

With the award of these contracts, we take a giant step toward making the safest and most efficient air traffic control system in the world even better.

RESEARCH AND DEVELOPMENT PROGRAMS

I would like to turn now to a brief discussion of our Research and Development programs. For FY 1989, we are requesting $155 million. As the Subcommittee well knows, our R&D program must meet the short term needs of the air transportation system as well as plan for and address the system of tomorrow, providing for increased safety, productivity, and capacity.

Through the support of the Subcommittee, we have, to date, been able to accomplish much in our R&D programs.

The Traffic Alert and Collision Avoidance System (TCAS) has made significant progress, and that progress will continue. During the current fiscal year, our major efforts have centered around improving the bearing measurements accuracy of the TCAS II Limited Installation Program units and demonstrating those improvements at the FAA Technical Center. Early this year, on January 29, United Airlines received a Supplemental Type Certificate for the Bendix TCAS II avionics for both the B737 and DC8 installations. Both units went into regular passenger service on January 31 and, as of March 1, more than 200 hours of operation have been accumulated. The certification of the Sperry unit on Piedmont and Northwest Airlines is expected this month.

In fiscal year 1988, the initial development and concept feasibility was demonstrated for the National Airspace System (NAS) Performance Analysis Capability. This was done by developing two computer models--a queuing model and a simulation model of the NAS. The fiscal year 1988 work addresses concept feasibility and is limited initially to 58 major airports. Our plans call for future expansion to include NAS en route structure and expanded airports and fix coverage in the United States. Our plans for continuation of the NAS Performance Analysis Capability through computer modeling will progress in fiscal year 1989. We will concentrate on the verification of the queuing and simulation

computer models, emphasizing NAS performance, capacity, and delay reduction and, in the future, will focus on expanding this operations research capability to include safety, economics, fuel usage, and other aspects of the NAS.

In fiscal year 1988, work was completed on the ATC application of Automatic Dependent Surveillance (ADS) to improve the monitoring and control of aircraft over oceanic airspace. In fiscal year 1989, engineering analyses, simulations and field trials will be conducted to establish hardware/software design and performance requirements for ADS.

We are also striving for improvements in aviation security, particularly in explosives detectability. In fiscal year 1988, we have completed the thermal neutron activation development test and evaluation, and we expect contract award in June. Enhancement of the vapor screening portal will continue in fiscal year 1989, with concurrent tests at an airport.

Lack of adequate runways is an emerging aviation crisis in this country. Hub and spokes, new route structures, saturation of certain airspace, and flight delays at some of our busiest airports highlight what is perhaps the biggest achilles heel and most difficult challenge in the years ahead--airport capacity. To meet this challenge, our FY 1989 budget seeks a substantial increase in funding for programs directly related to, or

supporting, airport capacity research. At Raleigh-Durham and Memphis Airports, we are using radar sensors to monitor closely spaced parallel and converging approaches. We hope to demonstrate that these systems will increase the capacity of high activity airports to accommodate higher levels of air traffic.

CIVIL AEROMEDICAL INSTITUTE

We are in the process of taking the necessary steps to improve operations at CAMI, our Civil Aeromedical Institute. This will be a difficult and drawn-out process, but I am committed to enhancing the stature of CAMI and revitalizing the quality of research performed there. The Subcommittee is well aware of the many problems that have developed there, so I will not belabor the critical need for improvement.

We are currently recruiting for a manager of our Toxicology Unit along with several supporting staff. We expect to be in a position to make offers to prospective candidates for these positions within the next several months. As an interim measure, we have been in contact with the Armed Forces Institute of Pathology about providing temporary support to us in toxicology evaluations, pending the necessary improvements to our toxicology capabilities.

We also have actively been recruiting a manager for CAMI, and have identified a number of potential candidates for this position. We continue to believe that it is imperative to fill this position with an individual who possesses both strong managerial and scientific credentials. The vacancy announcement for this position has just closed, and we will begin evaluating candidates shortly. We hope to have filled the position within the next two months.

Our Federal Air Surgeon, Dr. McMeekin, has been visiting CAMI on a monthly basis. Additionally, he has begun the process of opening up an exchange of information and ideas with academic, industry, and government institutions. Moreover, internally, the Office of Aviation Medicine has been working to better integrate CAMI operations into our overall medical programs, and we have made some progress in that regard, although much remains to be done.

In terms of the scientific advisory panel we plan to establish, we have begun evaluating potential candidates to recommend to the Secretary for approval. This panel will be instrumental in helping us evaluate the efforts at CAMI (as well as in our other medical programs), and in recommending research to be undertaken by CAMI.

I expect to finalize shortly the Report requested by this Subcommittee concerning our plans at CAMI. Part of that effort

also entails the development of a mission statement, which my staff is currently finalizing as well. These documents spell out generally the direction we believe should be pursued at CAMI, as well as the general thrust of how we will conduct our research programs there.

I believe it is imperative that the reshaping of CAMI, and the pursuit of research there, needs to meet two important criteria. First, the activities performed at CAMI should not duplicate other available research or programs in either the public or private sector. Collaboration with other academic, government, and industry organizations, of course, will be encouraged. Second, there must be value added by the efforts we undertake at CAMI; by that I mean that we will not perform research for research's sake. Instead, we will target our finite resources in a way that we are working toward a product that will measurably improve some aspect of aviation. All of our activities will be measured against these objectives, and steps taken to instill the necessary discipline into our processes to ensure that research continues to meet these fundamental objectives as it is carried through to completion.

We will keep this Subcommittee apprised of our efforts to improve the quality of effort at CAMI, and welcome your continued support in achieving needed improvements.

NAS PLAN AND R,E&D PROGRAM MANAGEMENT

In my assessments of FAA's management of the NAS Plan and our R&D programs, I have determined that improvements can be achieved through changes in the way we oversee and manage those programs. We are in the process now of making those changes to strengthen our NAS Plan and Research and Development organizations.

For a variety of reasons, I have concluded that the FAA needs an organization that can provide an independent and continuous NAS assessment; technical programmatic analysis to support the management decision process; and stricter management control and oversight of the baseline NAS design.

I also believe that, while the conduct of the agency's research and development programs has been effective in the past, we need an organization that will permit us to better focus and refine our R&D efforts to achieve greater effectiveness with the funds that are available to us.

To meet these new organizational requirements, I have established an Associate Administrator for Advanced Design and Management Control. This Associate Administrator will assume responsibility for providing an ongoing NAS assessment that will include management oversight and for providing remedies for deficiencies

uncovered in the oversight function. The new Associate Administrator will also ensure that our long-term planning is meaningful and cohesive.

I am confident that this new organization will provide new emphasis on finetuning the effectiveness of the R&D program in the FAA. In defining the new organization, I have built in "checks and balances" that will assure a close relationship between R&D activities leading toward future system definition and the follow-on programs that will develop future NAS improvements. The Associate Administrator for Development and Logistics will continue to be responsible for the actual conduct of the development programs. This close interrelationship between the two organizations will assure that advanced R&D planning is closely tied to reality. The Airport Capacity Program Office will also become part of this new organization, reporting directly to the Associate Administrator for Advanced Design and Management Control. This will ensure that the Airport Capacity Office continues to enjoy the highest management visibility in the FAA, while at the same time having a direct input in the definition of programs to increase airport capacity.

In closing, Mr. Chairman, I want to again thank this Subcommittee for its support of the FAA's programs and its commitment to the furtherance of aviation safety. Working together, I am confident that we can continue to make meaningful progress in behalf of the

American traveling public during the remainder of this year and in the program we have planned for next fiscal year.

This concludes my prepared statement, Mr. Chairman. I would be pleased to respond to any questions from the Subcommittee at this time.

Mr. McCURDY. Well, thank you for that quick summary, Mr. McArtor, and we do have a series of questions that we would like to pursue.

I think I'd like to cover just quickly for the record at the outset a couple of questions regarding the reorganization and I think then we have some specific areas of the R&D that are of concern to us.

I think for the record it is important to ask the question of whether, since we are in the waning hours of this Administration, whether it is appropriate to conduct a major reorganization, particularly since there is such lively discussion about the broader FAA future. There are bills being filed, I know, by Mr. Oberstar and others and some in the Senate for an independent FAA.

Also, yesterday Mr. Helms urged that this Subcommittee merge FAA's engineering, research and acquisition functions because he felt the two weren't communicating. The question is now why should they be separated?

These are some of questions that are heavy on the Subcommittee's mind, and we would appreciate a response.

Mr. McARTOR. To begin with, it was absolutely necessary for then Administrator Helms to consolidate. Because without it, we would not have been able to pull off a NAS Plan type of project. So, he had to consolidate engineering, and research and development as well.

This research effort, then, expanded. Even the same individuals expanded into those program managers of the NAS Plan, and are now even beginning to transition into some of the implementors of the NAS Plan.

As this R&D moved from research, development, contracting, engineering, and program management, it has left behind a vacuum of research and development that has not been filled well. And that's because of the competition for resources and time on the part of our managers.

So, we have to create a group, an organization, who is tasked with and held accountable for the development of requirements, the development in prioritizing of research and development, to be able to ride herd on that, who serves the customers well of ADL or ADL organizations, and which will also be able to consolidate the talents of operations research or the computer modeling, which we have to rely on if we're going to manage an efficient airspace and our airport capacity.

We've got to develop the techniques of ops research. We also have to have an organization that asks the tough questions, the management controls. So, we have to ask the why questions. And, knowing what we know now, are we on the right track? Are the programs meeting our expectations?

In order to provide the checks and balances to our high technology programs, we have to have a separate organization to look at that. So, this advanced design and management control organization provides a useful organizational tool to answer the tough questions, to provide continuity of ops research, and to develop appropriate requirements and research and development priority programs.

Mr. McCURDY. I think at the outset here we need a little clearer view. We understand that there are a number of studies. It's well

known that they're out there, and that, in fact, they've not been received yet.

But, without trying to anticipate totally where they go, could you outline for us what you foresee as the impact of the HumRRO study and the NEF, as it pertains to training? And, in addition, what potential reorganization would do to not only the research effort but other areas outside of research.

Mr. McArtor. Okay. With your concurrence, Mr. Chairman. I neglected to answer a very key part of your previous question. May I return to that, and then come back to this question?

Mr. McCurdy. Surely.

Mr. McArtor. You asked why would we do this, in what would appear to be the twilight hours of the Reagan Administration, when there's so much other activity going on, talking about institutional reform at the FAA.

Regardless of to whom the FAA might report in the future, this internal reorganization is very, very much necessary, if we're going to manage the types of sophisticated and responsive programs that we are going to be expected to in the future, or to continue the modernization momentum that we've worked so hard to create.

And, while this may be a slow-down year for many government agencies, this is very much an acceleration year for aviation. This is one of the key cornerstone years, as a matter of fact, in aviation. And to not be responsive this year, I think, would be very much a mistake for myself or any other aviation professional.

With respect to the training programs, since last summer, when I was sworn in and came on and created the Impact 88 Program, air traffic controller training—and, again, the agency effectiveness and the modernization of ourselves—air traffic controller training was one of the things that I knew had to be changed and improved upon.

I am not at all pleased, nor is the agency, that it takes three, sometimes longer, years to train a full performance level controller. We should be able to do it in much faster time than that, and we should have far fewer washouts than we have right now in our training.

However, our training program, which relies on on-the-job training, is sometimes effective, but extremely inefficient. We've got to develop better training programs, more sophisticated training programs, and to use advanced technologies and simulation to try to train our air traffic controllers before we send them into the operational world.

These are the programs, now, that we've asked for. Two independent studies—three, if you include the FAA study itself, technical training—but two independent studies, both looking at it from slightly different views, as to how we can improve the training for air traffic controllers.

These reports, now, will be due to us this month. We'll take a look at those, synthesize them, and then try to develop a road map for change, hopefully, by the end of the summer, with which we will then be able to begin the implementation of new training programs which feature, as a fundamental cornerstone, the use of simulation, site-specific simulation, which we've already proven to ourselves to be extremely valuable in training air traffic controllers.

That part of the organization may or may not be housed in a training organization. Right now that's one of the debates as to whether we really want to separate training as a stand-alone organization or whether we want to have air traffic controller training as a part of the air traffic control operations.

You can argue both sides of that, and we really haven't decided. I suspect that will be one of the things that we'll try to do by the end of this summer.

Clearly, our training center right now is the Aeronautical Center in Oklahoma City. That will continue to be the focal point of our training programs, as well as several other support functions that are down there. But that's where we look to as, in essence, headquarters for the implementation of the air traffic controller training programs.

Mr. MCCURDY. Mr. McArtor, the recent incident with the Aloha flight, and actually the most recent accident and incidents with aircraft, whether it's two inexperienced pilots taking off in a snowstorm or the fatigue in the aircraft or a 747 running out of fuel or fuel wasn't transferred appropriately.

Those kinds of incidents raise very serious questions about some of the R&D efforts and questions of human factors, as opposed to some of the traditional focus of the R&D efforts in your budget that was submitted to us, which goes primarily for the implementation of the NAS Plan.

What do you think can be done, and what is the role of institutions such as CAMI? What is the FAA's direction to bolster and improve the research efforts in those issues of human factors, smoke, questions of people in the cockpit? Are they prepared? What's the future of conditions that they're going to be working in? Those are a number of things that look further out, and at the same time also have some immediate impact because of the recent accidents.

Mr. MCARTOR. It would certainly be a mistake for anybody to think, when we talk about research and development with the FAA, that we are restricting ourselves to advanced technologies or the physical sciences, when, in fact, much of the research that is most appropriate for the FAA to be engaged in has to do with the research of the man/machine interface and the behavior of crews and the coordination between crews. We call it cockpit resource management.

A great deal of attention has been given to that this year. And I'm very pleased to say that, together with industry, the FAA is developing now somewhat of an improved syllabus of instruction with respect to cockpit resource management programs.

One of the roles that we can play in FAA, and particularly at CAMI, is to cause to happen the research required on some of the human factors activities. You don't have to do it all yourself. But you have to make sure that it's being done someplace, and be able to measure its effectiveness and then how it applies to the aviation industry.

Somebody has to keep tabs on what's being done at NASA, what's being done at Ames, what's being done in universities and outside in private corporations, to be able to make judgments as to the effectiveness of that human factors research on aviation. We'd certainly look to the FAA and CAMI to do that.

Do you want to add anything, Tony?

Mr. BRODERICK. No. I think we recognize, though, that we don't have that capability right now at CAMI. We have a core in Dr. Collins' psychology laboratory, which has a lot of experience in human factors, especially as it relates to air traffic control. We need to draw upon that and really build upon that.

We intend to be hiring a director of CAMI. In fact, the bids just closed at the beginning of this week, and we're pleased with the candidates that we have. We need to move quickly along those lines.

But this is going to be a year of defining the mission of CAMI, their collaborative relationship with other organizations in the government and in universities. And then rebuilding that activity to be a focal point for well-defined aviation-related research.

And it's not going to come quickly. It's also not going to come easily. And we're not there right now.

Mr. MCCURDY. Mr. Broderick, you were at the hearing we had in Oklahoma City on CAMI, and I think we highlighted some of the deficiences and the fact that there was a certain amount of atrophy that had occurred within that organization. And I think this Subcommittee was unanimous in its support for improving not only the goals and missions, but also ensuring that there's proper funding at that facility.

In a continuation of that question I asked Mr. McArtor, there are actually two points. One is where is the report on CAMI? And, secondly, in this whole R&D effort issue of cockpit and human factors, is the '89 budget sufficient or do you need more money in that area, and also in consideration of the recent incidents?

Mr. BRODERICK. Okay. The report is, I hope, in final draft right now. It has taken us longer than we'd like to put it together. Frankly, it's not the kind of thing we wanted to hurry, and it's a thing that we needed to debate internally.

And, as you indicated, there have been a lot of things going on at the FAA. I wish we could have done it quicker, but we're going to do it as quickly as we can and get it up here.

With regard to the '89 budget, Neal Blake and his folks on the R&D side have already laid out tentative plans for building up research in the human factors area from that budget. That budget is certainly adequate to begin the programs that we're going to be addressing at CAMI.

But, again, we're not there yet, so it's only a beginning. And it's certainly isn't going to be adequate to answer the questions and solve these problems.

We look to establishing longer-term relationships than one year, and we look to doing those in close collaboration with folks from industry who will specify what they're doing and what their needs are, folks from NASA, especially those at the NASA-Ames Research Center, and the military and other government agencies.

So, we intend to work collectively with other folks, and we're going to be starting that effort, actually, late in fiscal 1988 and early '89. And we're not going to be doing things that we duplicative of other activities.

For example, Northwest Airlines has a new company formed, a training company. It's doing a terrific effort on job-task analysis,

and developing a completely new training program for their needs. It's generally applicable across the borad to every airline company.

But by working with them and using that data, using the resources of a university consortium with Embry-Riddle and the University of North Dakota, people down at Oklahoma, we will be able to build, I think, quite a good program of collaboration, as opposed to independent work, with them and the NASA folks.

Mr. MCCURDY. Do you think we'll receive the report by mid-month, the end of the month? Can you give us something a little more specific? You say final draft. I'd just like to nail it down, if I could.

Mr. BRODERICK. I certainly hope we're going to finish that. I know I'm going to get it to the Administrator within the next week or so, and then we've got to coordinate through the appropriate offices in the Department and the Executive Branch, sir.

Mr. MCCURDY. Okay. Mr. McArtor, before I turn it over to my colleagues, I was particularly interested yesterday in the statement by Mr. Helms that he felt there should be a—and I'm using my own term here, but I basically felt like it was appropriate—something like an R&D czar.

Someone who's looking over all the R&D, that there's one person who is specifically charged with the task of coordinating those efforts and ensuring that there's not duplication, that current efforts are sufficient, and also outlining what the future needs are.

Does that conflict with your reorganization plans, or is that something that makes sense in your judgment?

Mr. MCARTOR. Perhaps Mr. Helms was right. What he's described is the Associate Administrator for Advanced Design and Management Control. That is the person. That is the czar who, together with our internal staff and the advice of industry and all will establish priorities for research and development, try to develop requirements for resources, to establish the requirements that would lead us then into full development and procurement programs. But that is precisely what the organizational structure that is proposed is going to do.

Mr. MCCURDY. Would this person have oversight jurisdiction over CAMI and NAS, or tell me how is that flow?

Mr. MCARTOR. Don't know that yet, sir.

Mr. MCCURDY. The gentleman from Florida.

Mr. LEWIS. Thank you, Mr. Chairman. Mr. McArtor, is the margin of safety in aircraft becoming unglued today?

I ask that question—you made the statement today that you are going to be looking at 291 other 737s. Now how about the 707s—did they use the same bonding process, and do you have a program or are you looking at a program set up for them?

Mr. MCARTOR. Without question, our most recent focus has been on the 737 aircraft because of the recent accident, and rather that wait for the National Transportation Safety Board to declare what the cause of the accident actually was and whether it was because of a failure to adhere to an established procedure or whether the procedure was at fault, I thought it out of an abundance of caution to establish emergency airworthiness directives to require additional inspections and tests of this type of aircraft. It is by no means to suggest that the 737 is somehow unique to any other aircraft type

that has several thousand cycles. Any pressurized aircraft, particularly ones built with aluminum skins are all subject to the same thing, but we already have in place inspection criteria. We have manufacturers' maintenance bulletins. We have techniques for repair and we have criteria for measurement of cracks and a great deal is known about pressure vessels and crack and fatigue propragation.

So programs exist right now for inspection of all aircraft types, be they 707s, 747s, 727s, DC9s, 737s, L1011s. All aircraft have criteria, because we know corrosion and repeated pressurization cycles can help contribute to the probability of crash.

Mr. LEWIS. Do you have a specific program or an additional type program to be used for those aircraft that are flying over salt water predominantly, or is that a little hard to judge?

Mr. MCARTOR. All carriers have an approved maintenance program which is reflective of their particular operating environment, and not all air carriers maintain their fleets the same way or have the same kinds of inspection criteria, so their program, both for operations and their maintenance program are tailored to their particular operating environment and obviously both the manufacturers, the carriers and the FAA are more sensitive to corrosion control programs in operating areas that would have salt water atmospheres.

Mr. LEWIS. Okay. I'd like to switch over to something else. How much non-NAS long range research focused on 5, 10, 15 years from now is FAA doing?

Mr. MCARTOR. We have an advanced concepts group that is not as aggressive as it needs to be. I made a statement last—probably it was last July, when I got sworn in—that we not only have to buy new equipment, we have to develop new concepts. We have to devote the energy and attention and funds toward the development of new core technologies, artificial intelligence expert systems, good data link from air to ground, air to satellite, and the ability to communicate with aircraft other than voice communications from controller to pilot.

We also have to develop more independence from our ground centers of radars and we are prepared to do that, but in order to develop a strategic plan, we have already formalized within the Agency an office that is charged with the printing of the first strategic plan that the FAA will have. We are also reconstituting and reinvigorating our industry advisory committee so that we can try to develop some long range objectives for the kinds of technologies that we ought to be pursuing. You have got to have a plan before you progress, and we are committed to develop that plan.

Mr. LEWIS. I see. Do you have a long range R&D program set up in FAA for aircraft maintenance?

Mr. BRODERICK. We have a number of requirements that relate to aircraft maintenance, especially in the area of new materials and non-destructive testing, composite materials work that is done, the non-destructive materials testing development that is done—I would put that in the now to, at the outset, 10 year kind of activity, rather than much further out than that.

Mr. LEWIS. Does that program also include aircraft that we have today after they have met 10 or 20 years of their life cycle?

Mr. BRODERICK. Well, we call it something different. We have a program in place today that has actually been an active program since about 1978, if memory serves, called the Supplemental Structural Inspection Program. What that is designed to do is to recognize that as an airplane is used, every day you are really entering into new ground with the fleet leader of the aircraft, the oldest aircraft in the fleet, whether it be in terms of cycles or in terms of years. What we have is a requirement that the manufacturer work with the airlines and develop—using the latest state-of-the-art technology, not the state-of-the-art technology that was extant when the aircraft was designed and built, but using the latest modeling, stress analysis, fracture mechanics technology, et cetera—develop based on actual, real world experience, inspection programs that are then laid back on all airlines, which must follow them as their aircraft reach specified thresholds.

These programs for each individual aircraft are required to be developed by the manufacturer and required to be followed by the operators and they are indeed very voluminous and detailed sets of documents. I mean a typical program for the 727 or an airplane—737—would be a foot or more thick, as you are familiar with them, I'm sure, sir.

Mr. MCCURDY. Will my friend yield a minute on that point?

Mr. LEWIS. I would certainly yield.

Mr. MCCURDY. I think he is narrowing in on an important topic and that is the issue of composites and advanced materials and this Subcommittee has jurisdiction over NASA, the aeronautics function, and I also sit on the R&D subcommittee in armed services, and to be quite candid, I am not sure anywhere in the Federal Government is there an adequate R&D effort ongoing to test the structure and the strength and the abilities of new composites in these materials to withstand stress, certainly not in the non-Defense arena. We have some in the Defense arena and I am not sure that even that is adequate. If the FAA dose not do it, I am not sure NASA is going to carry the load. The amount of funding in that area is very small. The whole issue, quite frankly, of manufacturing and processing is not developed or supported in the non-Defense area and at some point it takes this collaboration and this cooperation to ensure that the next generation of aircraft, whether it is a tilt rotor or the futuristic planes that are going to be built of these composites, that we have a complete understanding of their structure and I think the gentleman is absolutely correct and we would like to hear—you know, this is looking in the future, but it is a real problem, and something that I would FAA to move aggressively on.

Mr. BLAKE. We certainly agree with you, Mr. Chairman. We have initiated several efforts to look at a variety of the strength questions having to do with composite materials with NASA and within our own laboratories. We have been looking at foreign object damage, for example, methods of inspections to detect that, and working with NASA on the other hand with bi-directional materials, which would provide greater strength and greater resistance to losing large chunks of material when such damage occurs.

We are doing some testing on impact damage on composites—that is, where the aircraft impacts the ground—to predict and also

to measure what happens when a composite aircraft is in an impact situation, and to change over some of our analytical models to where you can predict in advance how a particular composite structure will react in a high stress situation.

Other aspects of the program deal with the effects of lightning, both on the structure itself and looking at the strength of materials, hole puncture and impact on avionics carried on board the all-composite aircraft.

So we have quite a wide variety of activities going on. There is one additional one that has to do with the fire characteristics of composite material, particularly as it relates to fuel fire or post crash fire, and this is also being done with input from the NASA laboratories. We are very much concerned in improving that technology.

Mr. MCCURDY. How much money are we talking about? Do you have any idea?

Mr. BLAKE. I can give you that in just a second.[1]

Mr. MCCURDY. Okay. The gentleman from Florida, please.

Mr. LEWIS. Mr. McArtor, how much of your—what percentage of your annual budget do you have allocated or have you allocated to long range R&D planning?

Mr. MCARTOR. If I can interpret your long range—if you mean by long range R&D those advanced concepts, it is but a very, very small fraction.

Mr. LEWIS. Now speaking of what Mr. Broderick brought up with your long range, 10 year programs, do you have a portion of your budget that is annually allocated just to that, in composites——

Mr. MCARTOR. Not specifically for long range R&D. One of the attitudes that I would like to be able to develop in the Agency and within the Congress is the understanding of just what does research and development mean.

We are often asked by those who would oversee the preparation of our budget what is the cost benefit analysis of this research and development. Well, right off the bat you know you are talking with somebody that really doesn't understand what is research. A lot of it is not easily quantifiable as to what the development benefit might be—that is the very nature of research.

But it would be strange to me where private industry would devote a certain percentage of sales into new product development or research and development, I think that we have to recognize that we in the FAA have an obligation as well if we are going to manage several billion dollars of upgradable and high technology programs. We literally have an obligation for some, if it is not on a percentage basis but for a substantial amount of money devoted against the continued modernization and the upgrade of concepts in our program, and that is what we are trying to do—to separate out again the competition for funding from the operations side of research, training, and education to try to figure out a mechanism by which they do not compete for the same resources.

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[1] The FAA is currently spending $750,000 for composite material testing.

Mr. MCCURDY. That's the second call, and the gentleman from Kansas is going to return in just a few minutes. I'm going to have him chair, so he can ask his questions.

I would also appreciate it if you would deal somewhat with the MODE C transponders and the recently proposed regulation. And, even if I'm not here, I'd appreciate it for the record, because I know this has been an issue.

Some of us have to admire your style for going out and tackling the problem. But I think we may have to have some reconsideration of the extent of the proposal, and would hope that you would have something on the record on that.

[The information is provided in Appendix A.]

Mr. MCCURDY. They've got the machine working now, so we don't have as much time. So, we should be back shortly. We'll take a 10 minute recess here, and Mr. Glickman will reconvene.

Mr. GLICKMAN [presiding]. Mr. McCurdy will be back in a moment.

Mr. McArtor, on June the 4th, 1986, this Committee had a hearing on the subject of geriatric aircraft. And at that time, Mr. Broderick testified.

I just want to repeat to you a comment I made in an opening group of comments, and then I want to go a little bit into the record. But I said the following, and just a quick parenthetical point, Mr. Chairman, on one of the spin-offs of deregulation:

> As new carriers enter the marketplace, they can buy older airplanes, much cheaper than new ones. So, you see these older DC–9s and older 727s, older propeller airplanes, all being used to transport people, sometimes under conditions which require dramatic utilization of these planes on a day-to-day basis. And I think one of the things in our hearings today ought to be to explore the useful life of these older airplanes, particularly as they are being utilized in ways that probably were never intended by their manufacturers.

Now, during that hearing—I think I've got a copy of the record here—we heard testimony from Mr. Broderick, as well as from the Boeing Company, Mr. Benjamin Cosgrove, Air Transport Association, and Mr. Jim Burnett of the National Transportation Safety Board.

All talked about this problem of planes getting older, flying longer, being designed to that, and that the older they get, the more maintenance problems there would be coming. In fact, Mr. Cosgrove, and he's with Boeing, testified, curiously, the following, talking about different kinds of airplanes:

> But if you take the other end of the extreme, which is the 737, which flies every 20 minutes, it'll have 70,000 flights in only 45,000 hours. Now, that is a goal which we set up for ourselves, and we design all of our aircraft to that particular goal. What you'll generally find is that the aircraft is considerably better than that. There are some parts of it that are considerably worse than that, and we would want to get those real quick." I presume he means maintenance. But, fundamentally, you'll generally find the aircraft will go further than 20 years. In fact, we're getting an opinion, in looking at the fleet that may be closer to 22 to 25 years before you start running into a lot of cost for maintenance purposes.

Now, I mention that because 2 years ago we began to have some worries about old airplanes flying in our society. And my own feeling is that we have a problem here, not so much that airplanes are flying that aren't safe, but they're flying under terms and conditions that the manufacturer never intended them to fly under, par-

ticularly under an economic climate of deregulation, which perhaps has minimized the amount of maintenance that we used to provide airplanes back in the 1950s and 1960s.

Let me give you a couple of examples. Recently, a few engineers have told me that, because our runways and concrete are not in pristine condition, that the structural damage to an airplane from repeated takeoffs and landings may, in fact, be greater than previously thought because of the concrete problems that may not be fixed as fast as they used to be in the old circumstances.

Therefore, takeoffs and landings may produce more structural stress than we had thought on an airplane and, coupled with repeated takeoffs and landings and deregulation, you've got greater problems. There's no question that with deregulation we're using airplanes differently and more frequently than we ever probably dreamed of when we built these airplanes.

Another engineer mentioned to me, he said: Well, the rule of thumb may be 50, 60, or 70,000 cycles. But, if in fact we combine all those cycles in the last couple of years and not overuse the airplane the first several years, you in fact skew those numbers a little bit by saying, well, maybe those cycles depend on how the airplane is flown throughout the life of the plane, not just at the very end.

I guess my point to you is that I am concerned about the structural credibility of a lot of older airplanes flying out there. I am concerned that the FAA has not done the research necessary to deal with items like structural fatigue, wear and tear, and damage of aircraft as a result of age and utilization of aircraft.

I know you have inspection criteria. That is not an R&D program, however. And it depends on the airlines doing a lot of that inspection that may be based on criteria which is not modern or realistic in terms of how airplances are flown today.

So, I realize that I'm giving you a lot of different pieces of the pie, and you're not at fault for any of this stuff. But the point is that we must make people secure that the airplanes they're flying in are properly maintained and inspected in light of how they are flown.

This accident was very frightening and traumatic to the public, because it led them to believe that maybe we're not looking at these planes as we need to look at them. So, I would make two comments to you.

Number one, if we don't, should we not have an operational research program on sturctural fatigue, utilization, wear and tear, and damage of aircraft? If so, who should do it, you or NASA?

And, secondly, instead of just inspecting all very old 737s, should we not be inspecting almost all airplanes that are flying today, except the very new ones, in terms of these kinds of structural problems raised by that Aloha Airlines airplane?

Mr. McArtor. Mr. Glickman, you, of course, did in fact mention several things. I'd like to address just a couple of the points that you made.

To begin with, yes, we are inspecting. We, the industry, are inspecting older aircraft with greater frequency. There are procedures in place and airworthiness directives, literally dozens of them, addressing this subject, with authorized repair techniques

being done every day, the inspection for cracks, for corrosion, and the fixing of those things according to procedures.

The phenomena of an aging fleet, or the potential dangers that might occur from catastrophic failure, fatigue failure, or rapid decompressions are not at all a current or, I'll say, a recent concern. You mentioned a couple of years ago we had our attention called to this.

Since World War II, there's been a great deal of work done and a lot of understanding of pressurization cycles and fatigue cracks and corrosion. That's not to say that we don't have a lot more to learn as well, because we are flying aircraft, we, the industry, are flying aircraft beyond what may have been considered to be their design useful life at the time.

Which simply means that the inspection criteria has to be where it's not dependent on—you don't have a useful life that says that at some date certain the aircraft cannot fly again.

But you would have an inspection criteria that says, as long as you inspect carefully and see no evidence of wear or cracking, then there is no reason to believe that that aircraft can't have a sustained useful life.

And that goes for all aircraft types. This is not just focused on 737s or anything else.

The manufacturers, at the same time, obviously, are very interested in the useful life of their own products. Boeing for instance, since we're talking about the 737, has an aging fleet program. It's managed by a senior executive at Boeing.

They've actually bought hulls. They've pressurized them repeatedly to failure. One 737 hull, I think, went about 130,000 pressurized cycles before it had any cracking and rupturing.

But there is no question that this latest accident with Aloha causes us to reexamine a great deal of what we had either previously known or thought we had previously known, and certainly to question whether our procedures, which we feel to be adequate, were in fact properly done. Normally, when you have a pressure blowout, it's a rather small area. I mean, this literally tore the top of the airplane off.

So, we either had an uncanny coincidence of failure sequencing one behind another as they passed along the rivet line, or the inspections conducted up to that point were not done properly. Obviously, we certainly look to the NTSB to assist us in understanding what actually happened in this particular circumstance.

As far as continued research in this area, I think the FAA, its structures people, particularly the Northwestern Mountain Region, in conjunction with the industry, stays on top of this subject pretty carefully. However, that's not to say that there could not be more focused research and development in this area.

Mr. GLICKMAN. Well, I think you answered my question responsively and I appreciate that. I am still not satisfied about this research effort.

We discussed this yesterday in terms of the nature of the FAA's research program, how little of your research program actually goes into operational research items. And you are very focused, obviously, on the air traffic control modernization system, which I understand.

NASA does a lot of the research programs which, in my judgment, have more of an operational tinge to them than does the FAA's research programs. You know, in terms of deicing. I mean, you've done a few things, the crash/burn incident involving the Boeing 720 was one of your deals.

But for the most part, there does not seem to be a very focused effort within the Government of the United States to deal with operational research. Most of the human research is done in NASA.

And I'm not sure I care where it's done, other than that we are facing a problem now where more and more of our fleet are older, fewer and fewer of our pilots are of the Air Force generation that have a long-term history and experience that will build up as time comes, and we have a lot of airplanes being flown differently than they were before.

It all creates a new set of circumstances in aviation. It's not like the 1960s any more.

And I just want to make sure that, in terms of how you deal with this problem, that you not only cooperate with the NTSB but that you recognize that operationally this issue of maintenance inspection of aging fleets flying in a deregulated environment is just as important to your function as designing an air traffic control modernization system. I guess that's my point.

Mr. MCARTOR. Your points are well taken, sir.

Mr. GLICKMAN. Now, on the question of inspection criteria, how often are those updated? Or, are they ever updated?

Mr. MCARTOR. Well, they are continually updated in the sense that—I don't know. On average, Mr. Broderick probably can help us out here. But we issue airworthiness directives as we learn new things.

The airworthiness directive issued last November with respect to the 737s was an update following inspections, the results of inspections of the fleets that are flying. And, based on what we learned, we updated then the inspection criteria, the frequency of inspection, and new techniques, and new obligations, quite frankly, on behalf of the carriers.

The manufacturers do the same thing with respect to their maintenance bulletins. Or, in this case as it was last fall, an alert maintenance bulletin, as they learn more from this. So, they're constantly updated, both from the manufacturer and from the FAA's point of view.

Mr. GLICKMAN. And then it becomes the responsibility of the airline to comply.

Mr. MCARTOR. Very much so. Now, when we would inspect an airline, typically, we would go—and in the issuance of an AD, we would check to see compliance with the sign off of that airworthiness directive.

We would on occasion, of course, go look at the iron itself and do that on more of a spot basis, but we would look to see if the airline conducted the inspection and signed off on it, and that the people who did the inspection were qualified mechanics to do that kind of work.

But I think it is also safe to say that the FAA cannot be the guarantor of all work being done properly all the time.

We certainly don't look over the shoulder all the time of the work being done, nor do we conduct the work ourselves, as you well know.

Mr. GLICKMAN. Just as long as periodically you instill the fear of God into the airlines who are really the implementors of your responsibility.

I mean, I realize you don't have the resources to do it all.

Mr. MCARTOR. I think, at least from my conversations with the airline industry, they have a very healthy respect for our inspection program.

Mr. GLICKMAN. Let me just ask one final question. The cold bonding process at the lap splice, when did you discover this in terms of how this might have been a potential cause of problem in the Aloha airline situation?

And, are other airplanes bonded using this same process?

Mr. MCARTOR. The first question would be easier for me to answer in that the cold bonding process has been known for years to be perhaps a less effective bonding process.

That's why, of course, the manufacturer goes to a different bonding process. After the 291st airplane built, they went to a different process, which was more superior, more state of the art.

We have been aware that there is a tendency for delamination, debonding. Obviously, the industry has probably known that for years.

Mr. BRODERICK. I believe the first service bulletin was issued about 15 years ago on the process, the beginning of a series of service bulletins, which eventually turned into an airworthiness directive.

Mr. GLICKMAN. Now, did manufacturers stop using this bonding process at some point in time?

Mr. MCARTOR. As better techniques of manufacturing, yes. As a normal progression of upgrade of any fleet. Now, you asked about had it been used on other aircraft types.

I really don't know the detailed answer to that. It would be my presumption that if that were the state-of-the-art at the time, the answer could probably be, yes.

Mr. GLICKMAN. So, I mean, it would be silly to speculate on that now. I presume, however, that if that is a potential problem in terms of aircraft that have gone through many cycles, pressurization cycles, on one type of aircraft, it would also be a problem on other types of aircraft as well, conceivably.

Mr. MCARTOR. Yes, sir. And while I do want to make clear that there is a great deal probably left to be learned about cracks and the formation of cracks on aircraft, by all means, I also want to leave you with the impression that it is not near as much a mystery as one might suspect just because of this phenomena being in the news here in the last couple of days.

There's an extreme amount of knowledge base about this kind of phenomena and an awful lot of procedures and approved processes in place to take care of these things right now.

Mr. GLICKMAN. Well, unfortunately, to the public, if there's an extreme amount of knowledge base, they wonder why didn't we have the knowledge to prevent it from happening.

Mr. MCARTOR. Precisely.

Mr. GLICKMAN. So, that's all of our jobs, to make sure, try to make sure, that it doesn't happen again.

Mr. MCARTOR. Indeed.

Mr. GLICKMAN. Thank you. Mr. Price.

Mr. PRICE. Thank you, Mr. Chairman. I want, first, to express my appreciation to Chairman McCurdy for inviting me to sit in on this hearing today.

I am a member of the Full Committee, but not this Subcommittee, and I appreciate the chance to hear Mr. McArtor's testimony. I appreciate your statement.

I would like to focus more specifically on your agency's research and development efforts. In your statement, you describe the lack of adequate runways as an emerging aviation crisis in this country, and you designate airport capacity as a major area of vulnerability.

You specifically referred to experimental efforts that are now underway at the Raleigh-Durham Airport in North Carolina, and at Memphis, to narrow the spacing between runways which can be used for simultaneous parallel approaches in bad weather.

The successful development of these experimental systems should increase the capacity of high activity airports, such as the Raleigh-Durham Hub, to accommodate higher levels of air traffic.

I wonder if you could give the Subcommittee an update of how these experiments on the parallel runway monitor demonstrations that are underway at Raleigh-Durham and Memphis, how those experiments are going?

Mr. BLAKE. Thank you, Mr. Price. We are developing two differenct systems, one based on back to back antennas on a standard Mode S terminal surveillance system.

That unit will be placed in service in July at the Memphis Airport. We will be monitoring, from July through the end of the calendar year, on closely spaced parallel approaches.

And then starting in January, for another six month period, we will be looking at converging approaches, independent converging approaches at Memphis.

The second program at Raleigh-Durham draws on the technology developed on the TCAS program, and it uses a different type of antenna, an electronically scanned antenna, where we can vary the surveillance rate to test different strategies for detection of blunders.

And we will have that in service in November of this year, and it's our intention to operate it for approximately one year in experimental mode, taking data on pilot performance in flying the parallel approaches, and using that to drive our models on risk analysis.

The program has been going very well on the development of both of these equipments.

Mr. PRICE. Assuming one or both of these experimental systems turns out to be successful, what are your next steps, then?

Mr. BLAKE. Well, it is our plan, if these experiments are successful as we expect they will be, it is our plan to procure additional systems, and there are approximately ten airports that would be candidates for this type of surveillance system, with runway separations between 3,000 feet and 4,300 feet.

Now, there is a further application, we think, for this type of equipment at airports that have approaches to converging runways.

And there are approximately 38 airports, high density airports, that might use this same type of equipment to get added capacity at lower weather minimums.

Mr. PRICE. You say ten airports that would immediately be candidates for this type of equipment, and then a possible 38 additional sites?

Mr. BLAKE. There are 38 additional sites for converging. The ten relates strictly to the closely spaced parallel approaches.

So, it's really two different applications for the same equipment.

Mr. PRICE. Are both Memphis and Raleigh-Durham included in this number?

Mr. BLAKE. Yes. They are included in the ten.

Mr. PRICE. Well, assuming that this testing is successful, then what would be the advantages, the possibility and the desirability, of upgrading the radar at Raleigh-Durham to certifiable status at the end of this testing period?

In other words, leaving this equipment in place permanently?

Mr. BLAKE. The equipment is not built to the NAS standards and does not have remote maintenance monitoring equipment and a number of other capabilities built into it.

I think one option that we're looking at that may be promising would be to continue to operate the equipment until we could replace it with production equipment, which would be another year and a half.

Mr. PRICE. Another year past the experimental period.

Mr. BLAKE. And, of course, whether we can do this or not depends very heavily on the results that we get out of the tests and on the actual performance of the equipment.

So far, the antenna tests have looked very good, and we're quite hopeful that the equipment will perform well, but it is still a piece of R&D equipment.

Mr. PRICE. Once the tests were done, once this upgrading were achieved to certifiable status, would that possibly allow the technological advances of this type of radar to be used more quickly in other airports throughout the country?

Would that facilitate the transfer of this technology to other systems?

Mr. BLAKE. Well, we are planning, assuming success in both of these experiments, to put additional units into our F&E capital equipment request, possibly as early as FY 1990.

That would make the technology available to other airports starting in 1991 for one of the systems, and about a year later for the other.

Mr. PRICE. And would the upgrading of the equipment at Raleigh-Durham facilitate in that process? Is it relevant to that process?

Mr. BLAKE. No, sir, it is not. But we would operate the R&D equipment simply for another year, year and a half, until we could put in full NAS-type equipment.

Mr. PRICE. Would you envision any effort to dismantle the experimental system? The question naturally arises if this system is in

place, if it works, if it would be practical to upgrade it, would that not be preferable to some kind of dismantling of the system that would require that reinstallation at some later date?

Mr. MCARTOR. Mr. Price, if I may, because I've spoken with the carriers that use Raleigh-Durham at some length about this. Clearly, if the test program is successful, and if there is value added useful operational assistance that the interim or development system can provide, we're not opposed to leaving it in place to provide some type of operational assistance.

But, I don't want anybody to assume that a test or development system is, in fact, an operational system. We would be very sensitive to how it would be used, because if we're going to rely on it for actual closely spaced parallel runway operations without having built into it the redundancy and the reliability and capability that we would have in a production system, I think we'd be fooling ourselves.

But there may, in fact, be some operational advantage. And, if so, we'd be more than happy to try and continue that.

It works to everybody's benefit to do that.

Mr. PRICE. Yes. Is there any way, at this point, you could estimate the kind of funding it would require to allow this kind of prototype system to be upgraded in the way you describe, to be upgraded to certifiable status? Any way to estimate that at this point?

Mr. HARRIS. Not from my point of view.

Mr. MCARTOR. No, I don't believe so, sir.

Mr. PRICE. Well, it seems to me as this experiment moves along, and of course, we all hope that the experiments will be successful, that they'll be open to wider application, I do hope we can keep in mind the needs of this particular hub and also the possibility of upgrading this system, of perhaps saving additional installation costs down the road, and using this system in a way to permanently maintain that increased capacity that this hub system calls for.

Mr. MCARTOR. This system, under any event, would be removed and replaced with a production system when the production systems would be available.

We wouldn't leave a test or breadboard system in place for an extended period of time. But while the production systems are literally being manufactured and delivered, there may be some operational benefit to continue with a post-development test operation of the equipment.

Mr. PRICE. In other words, keep the experimental system in place past the period of the experiment.

Mr. MCARTOR. If there's some advantage to that, we certainly would consider that. Like I say, it would work to our advantage as well as the users of that hub.

Mr. PRICE. And as the experiment proceeds, we'll be in a better position to assess whether that really is possible and desirable?

Mr. MCARTOR. Yes, sir.

Mr. PRICE. All right. Thank you very much. Thank you, Mr. Chairman.

Mr. GLICKMAN. Thank you, Mr. Price. Mr. McArtor, just a couple of other questions. One, I want to repeat, I would hope that you would go back and look at the possibility of an R&D effort on aging

aircraft, and what kind of a program that would entail, and what kind of costs, because I'm interested enough to want to pursue this matter when we get to the appropriations bill.

I hope you would have your folks take a look at it to see what is there and what would be appropriate.

Mr. MCARTOR. With your permission, Mr. Glickman, I'll take that on as a task, but I would like to involve our other research organizations——

Mr. GLICKMAN. Sure.

Mr. MCARTOR [continuing]. In this country, the Department of Defense——

Mr. GLICKMAN. Absolutely. I don't mean just——

Mr. MCARTOR [continuing]. And aircraft manufacturers. But clearly, if the FAA needs to take a leadership role, we're certainly prepared to do just that.

Mr. GLICKMAN. Okay. Second of all, could you supply this Committee, for the record, as to the relative—I'm trying to define the best way to do it—the relative utilization of commercial aircraft that are flying today in terms of cycles?

Mr. MCARTOR. We call them Ute-Rates, the utilization rates. When you alluded to the fact that some aircraft may have been operated differently than had been intended by the manufacturer, that really doesn't mean any kind of safety implication, but an aircraft that was designed for more cross-country flying and it's now used in more of a commuter mode or a short haul mode, it may have substantially more cycles on it than it has hours, which exceeds what the manufacturer thought that the use of the airplane might be.

But, nevertheless, with an adequate inspection program, that should not be a major factor.

Mr. GLICKMAN. What I would like to see, if you could provide us that data, is then we maybe could determine, you know, what carriers have what kinds of airplanes; and I assume you do that yourself and determine——

Mr. MCCARTOR. Yes, we can give you a fairly detailed analysis of utilization rates and mission profiles of the various carriers.

Mr. GLICKMAN. I sure would appreciate that. Yesterday, former Administrator Helms indicated that perhaps the FAA ought to consider urging air carriers, with respect to hubs, to share the wealth, by, for example, developing new hubs at—and he mentioned Oklahoma City, Wichita, I don't know why he'd mention those two but I think Raleigh-Durham already is a hub, or a development hub, Colorado Springs, I forgot what other communities he mentioned.

But, he just said that there is a lot of airspace out there that could be utilized for hubs, that could help relieve the problems, and, you know, I don't want to go into economics of why airlines select different hubs, but he was speaking about the trust fund emphasis on the existing hubs, where so much money is put into them.

I wonder if you might have any comments on that?

Mr. MCARTOR. Part of our initiative with respect to airport capacity research and development and air space management, is to look at new concepts of networking with respect to the national

airspace, and that goes then to the utility of building airports as hub airports.

An example might be, clearly, Atlanta is one of our major hubbing airports. Not everybody that flies through Atlanta either gets on or gets off in Atlanta, originates or departs.

If, for instance, you went outside of Atlanta and were to build literally a switching airport that does not have any rental cars or baggage handling or taxi cabs or parking lots or whatever, it would be a less expensive airport to build.

It would be in a less expensive countryside. The infrastructure of the airport truly would be for the switching of people and baggage onto other flights.

And then, of course, if your destination were Atlanta, you could, either through high speed ground or some other means, get into Atlanta.

That kind of concept of trying to offload some of the major hub airports with other switching hub airports is kind of an interesting concept.

And those are the kinds of things that we do when we look at new techniques for airport development.

Mr. GLICKMAN. Well, I don't want to imply that neither Oklahoma City or Wichita don't have taxi cabs and motels and other kinds of things there, you know.

Mr. MCARTOR. The necessities—you get my point. The necessity is that if all you are doing, of course, is switching between airplanes, an airport didicated to that, of course, would have less of an infrastructure required to build around it.

Mr. GLICKMAN. Let me move on quickly to the issue of Mode C transponders. You and I have talked about this issue, and I know that you receive thousands of letters complaining about the FAA's proposed rule in response to legislation by Congress, directing carriage of altitude reporting transponders.

I wonder where you are in all of this right now? What are your plans with respect to the originally proposed rule and what you might do after the comment period ends.

Mr. MCARTOR. The comment period extends to May 12, and I really can't comment on what the changes may be until the end of that comment period and we have a chance to take a look at it.

I think it would be safe to say that in response to the comments received, there will be significant change in the architecture of that role, to try to be more balanced and responsive to what we feel are the needs of aviation and the risks in the system that we have to provide a buffer for.

We certainly do appreciate Congress' concern in this, and I do, in fact, believe when the Congressmen tell me that we've exceeded what their intent was, that probably is also true.

But, we did, in fact, issue a rule that is precisely reflective of what the Congress told us to do. So, I'm glad, now, that we're in sync and that we, the FAA, will be allowed to develop the final rule, and I think it will be a rule that the Congress can recognize as the kind of thing that they intended to start with.

Mr. GLICKMAN. Well, as you and I have talked about before, obviously, the Congress did speak to the issue of collision avoidance sys-

tems and air traffic concentration, and I think, perhaps, your folks responded too literally.

You know, sometimes we don't want you to follow exactly what we tell you to do. Other times, we do want you to follow.

Mr. MCARTOR. Thank you for putting that in the record, sir.

Mr. PRICE. Would the Chairman yield?

Mr. GLICKMAN. I'd be glad to.

Mr. PRICE. Could you give us some indication of the time table you're following in this matter?

Mr. MCARTOR. We're obligated to have a final rule by June 30th. We feel that we'll be able to make that time table.

It requires some very, very rapid coordination which we are prepared to do with the Department and with the OMB. We have received, I'm going to say, certainly over 60,000, maybe less than 70,000, cards and letters, some of them helpful, with respect to the alternatives that we might want to consider.

I've had meetings with representatives of the general aviation community, several meetings with members of Congress, and other parts of the industry, and I believe that we have an understanding of the kind of balance now required for a good Mode C rule.

There will be a Mode C rule. It's required. But I think it will be substantially changed from the one that hit the streets for the NPRM.

Mr. PRICE. Thank you, Mr. Chairman.

Mr. GLICKMAN. Thank you. Well, of course, we have some concerns about the capability of ground systems to handle all the additional information, which I'm sure you are looking at as well, in connection with not only this issue, but use of Mode C generally.

The other area that we remain concerned about has to do with aviation weather and dissemination of weather information.

At our hearing on weather last September, we discussed the GAO finding that FAA plans for dissemination of information from the new equipment lagged the equipment acquisition and I would—probably what we're going to do is ask you in writing to respond as to what progress has been made and how it is addressed in your budget request, other kinds of things, because that one may require a more precise answer because we're going to have probably some specific questions there.

Other members may have additional questions for you. So, for the record, we were going to keep it open for ten days so that we can maybe put those questions together in writing for you.

[The information is provided in Appendix A.]

We appreciate your being here, and your folks as well, and, from a personal point of view, I appreciate your commitment to air safety and everything that you've been doing since you've been on the job.

The hearing is adjourned.

[Whereupon, at 4:25 p.m., the Subcommittee recessed, to reconvene at the call of the Chair.]

APPENDIX A

QUESTIONS AND ANSWERS FOR THE RECORD

Question: Mr. McArtor, Public Law 100-223, the Airport and Airway Safety and Capacity Expansion Act of 1987, contains report language regarding aircraft noise:

"Of the funds authorized for Environmental Programs, no less than $2,000,000 is earmarked for research in Aircraft Noise Reduction and Control. The research shall examine new and innovative technologies, in cooperation with other agencies including NASA, to control noise generated by aircraft and in the development of effective noise operating procedures. Specifically, the research should investigate noise abatement for airports that have a high density of private residences and educational and medical facilities in close proximity. The innovative noise abatement research should also include effective noise insulation of private residences."

Mr. McArtor, could you tell the Subcommittee what research the Agency has underway that would fulfill the report language on aircraft noise just cited?

Answer: Although no appropriation for Aircraft Noise Reduction and Control has yet been made in response to P.L. 100-223, the FAA has work already underway in several of the areas of interest. For example, the FAA, in cooperation with NASA and the Transportation Systems Center, has conducted studies of the en route noise levels from operations of aircraft powered by the advanced turboprop (ATP) engine. Because the ATP is more efficient than today's high bypass ratio turbojets, some experts expect these new engines to replace current turbojets over the next decade. Since the ATP's are initially somewhat noisier, both government and industry are looking for ways to modify the noise output without impacting the improved fuel economy.

The FAA is developing a joint soundproofing research effort with the U.S. Army Construction Engineering Laboratory. Although the final plans have not yet been finalized, they will include development of specific guidelines for soundproofing residences. The FAA has already issued guidelines for soundproofing public buildings, such as medical facilities and schools, around airports. Such guidance is necessary because of the unique noise signatures and directivities of aircraft noise.

Question: The Stage II aircraft may continue flying until the year 2010. Does FAA have plans to accelerate noise abatement research so that the Stage II aircraft can be retrofitted to Stage III? What can FAA do to accelerate the use of Stage III aircraft and the removal of Stage II?

Answer: In April 1986, the FAA presented a Report to Congress on alternatives available to accelerate commercial fleet modernization. Although the report discussed a wide variety of alternatives, the FAA did not make any specific recommendations. Instead, the FAA committed itself to analyzing the various program elements necessary to developing a comprehensive strategic plan. This planning is still underway, with appropriate input from industry and various elements of DOT.

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Topic - Mode C Rulemaking

QUESTIONS

1. Please describe the capability of ground systems to utilize additional information available from new Mode C transponders? Specifically,

   o will the new signals saturate the radar environment? the automation systems? the human controller?

   ANSWER: There is very little direct impact on either the radar beacon or the digitizers. However, there is the potential for having to invoke additional restrictions on sending primary search radar data from some en route radar sites due to modem/phone line capacity limitations. We are living with these limitations today, because they occur infrequently.

   Both the terminal and the en route automation systems have the immediate capability to handle the anticipated increase in Mode C information.

   In the terminal automation systems, however, many of our higher activity facilities have limited capability to accomodate the future additional transponder growth that is likely to occur with this rule change. Approximately 70 percent of the terminal facilities will reach maximum capacity prior to replacement by the advanced automation system.

   The en route automation systems have limited capacity for growth in the display system area and the additional transponder growth that is likely to occur will further reduce that reserve capacity.

   In the terminal systems the human controller will have the potential for the display of anywhere from 20-25% additional limited data (altitude) blocks on the controller display. This in itself is not seen as a significant problem. However, depending on the individual controller display automation system adaptation, such as filter limits, and other display settings the display may be subject to noticeable flicker at the higher data requirement.

   In the en route systems the human controller will have the potential for the display of anywhere from 10-15% additional limited data (altitude) blocks. No impact is anticipated.

   o will the saturation occur only at particular times or sites?

   ANSWER: Saturation could most likely occur during peak aircraft operation periods at the busiest terminal air traffic control facilities. At the individual controller display, saturation may occur as a result of site specific automation system adaptation for that time period/operational configuration.

(continued)

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o what is the response to the saturation?

ANSWER: While no immediate terminal system saturation is anticipated, plans are underway to study the continued application of range/azimuth and other non essential data filtering for immediate terminal system relief should it be necessary. Near term saturation response is addressed in the answer to Question 2.

No saturation is anticipated in the en route automation systems.

o what automated means exist for using the added information from a VFR aircraft not in communication with a controller, such as Mode C intruder logic? in terminal airspace, or en route airspace?

ANSWER: There is no current automated means for using the added Mode C information in the terminal airspace. This would require the addition of Mode C intruder automation system logic.

The en route airspace will have the Mode C intruder logic operational in all the en route automation facilities by the end of this year.

2. What future plans are there to improve any deficiencies, or to make more use of the available data, or to keep pace with future growth?

ANSWER: The FAA currently has plans to address all three of these areas. The interim support plan and Mode C intruder plan have an anticipated contract award of August 89 and will provide the following:

Interim Support Plan (ISP) - The ISP will provide new Full Digital ARTS Displays (FDAD) for use at the higher activity ARTS III facilities which will eliminate display data capacity and flicker potential.

The ISP will provide ARTS III core memory changeout to state of the art solid state memory which will increase memory to the maximum size of 256K and increase processing capacity by 20-25%. This will accomodate system growth and serve as a building block for the addition of Mode C intruder logic.

Mode C Intruder Plan (MCI) - The MCI plan will provide the additional processor hardware and software to take full ARTS III automation system advantage of the additional Mode C information by providing conflict alert where at least one of the aircraft pair in conflict is under positive control.

(continued)

3. We understand there are questions of accuracy of data produced by less expensive general aviation transponders and encoders. Is FAA looking into this? Will manufacturing or maintenance intervals need to be changed?

ANSWER: In September 1986, the FAA's Office of Flight Standards released a report detailing an in-depth study and analysis of transponder performance. The result of the study indicated that the cost of general aviation transponders affected the performance and stability of the equipment. As a result of the study, the FAA has now identified funding to gather field data on in-service transponders and encoders using specially designed automated test equipment. The gathered data will further define the root problem of performance. The results may indicate a change to the Federal Aviation Regulations as required regarding periodic inspection and maintenance of the transponder system.

4. Would you comment on the recent Congressional Research Service assertion that doubts TCAS II effectiveness in the terminal environment: (The report says, "The TCAS II collision avoidance system is still in the developmental stage and its effectiveness in the all-important terminal environment has not been established. Should the system prove ineffective in the terminal environment due to an excessive alarm rate or radar signal interference problem, the full safety potential of TCAS II will not be realized.")

Answer: TCAS II is a fully mature system with over 10 years of FAA/industry development.

Safety studies, performed under contract to the FAA, indicate that incorporation of TCAS II would more than halve the risk of experiencing a near mid-air collision.

Piedmont Phase II operational evaluation has been completed. Over 800 hours of observed operation on TCAS II were accumulated. The program was extremely successful.

The questions of operation in the congestion of the terminal environment has been considered. Improvements have been made to the collision avoidance logic to, among other things, improve systems effectivity in terminal areas.

COMMENTS ON H.R. 3779

1. Mr. McArtor, as you know, I introduced legislation last December, H.R. 3779, the Air Traffic Controller Performance Research Act, which was referred to this Subcommittee. The bill is supported by many of the members on this Subcommittee including the Chairman, Mr. McCurdy. The bill will permit the FAA and NASA to conduct research to determine how automation will affect air traffic controller workload and staffing requirements. It will also develop new criteria and training methods for the next generation of air traffic controllers.

The bill is also designed to make sure our air traffic controllers are properly trained when technologies from the NAS modernization plan come on-line. To this end, the study will concentrate on improving and accelerating future air traffic controller training through the application of advanced training techniques, including the use of simulator technology.

The bill has the approval of both NASA and the FAA. However, I have not had an opportunity to solicit your views on the legislation since its introduction. I would appreciate your comments and suggestions.

Answer: It is my understanding that our Office of Chief Counsel provided a drafting service to your staff to assist in the formulation of your legislation. In addition, I have met with you and your staff to discuss our plans to apply advanced training techniques, including simulator technology, for future air traffic controller training, as part of my Impact '88 Program to increase the FAA's effectiveness. I have been advised that elements of your proposal have been incorporated in a new bill which includes other areas of research as well. We are currently assessing that legislation in order to develop a position on it.

Under my Impact '88 Program, we are well underway toward achieving the broad objectives of your proposed legislation. As the NAS Plan components are delivered to the field and increasing demands are placed on our air traffic control system, it is incumbent upon us to exploit state-of-the-art technologies. In the area of controller radar training, for example, a research prototype is being developed that will be used to evaluate the viability of utilizing expert system technology (a form of artificial intelligence) as an "expert monitor" for students exercising radar training simulations. This would allow instructors to tailor training program needs of the individual classes and to increase

the size of those classes. The initial work will focus on terminal air traffic control radar training and will be followed by an extension of the techniques to the air route traffic control center environment.

In the area of flow control management, work is beginning on the development of automation capabilities that will generate alternative flow control strategies for national traffic control managers. To enhance the sensitivity of those alternative strategies to actual, real-time conditions, research into an expert system application will be included in that work.

In addition, we are studying cognitive and technological advances, including simulation delivery systems, to improve air traffic controller training. There is a need to accelerate the progression of air traffic controllers to full performance level (FPL). Academy screening requires 11 weeks. Controllers then receive 2-3 years of facility classroom and on-the-job training to attain FPL status. We are analyzing our current training policies, practices, and methodology in order to improve and expedite the training process. These studies will produce short-range and long-range plans for modernizing air traffic control training with an emphasis on the use of advanced training technology to produce well-qualified full performance level controllers in the most expedient and efficient manner.

I welcome your interest in the need for improved controller training and look forward to your continued support as the FAA takes the necessary steps to meet the present and future air traffic control needs of our air transportation system.

APPENDIX B

INDUSTRY TASK FORCE ON AIRPORT CAPACITY IMPROVEMENT AND DELAY REDUCTION

TESTIMONY OF

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Chairman of the

INDUSTRY TASK FORCE ON AIRPORT CAPACITY

IMPROVEMENT AND DELAY REDUCTION

On

FAA'S RESEARCH AND DEVELOPMENT PROGRAMS

Before the

Subcommittee on Transportation, Aviation and Materials
Committee on Science, Space, and Technology
U.S. House of Representatives

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Mr. Chairman and Members of the Subcommittee:

I am J. Donald Reilly, Executive Director/Secretary General of the Airport Operators Council International (AOCI) and Chairman of the Industry Task Force on Airport Capacity Improvement and Delay Reduction. On behalf of the Industry Task Force, I wish to express our great concern over the serious capacity problems facing our Nation's airports and the aviation system and the need for much greater FAA research and development efforts and resources dedicated to enhancing capacity.

Presently, 18 major airports are seriously congested, experiencing over 20,000 hours of delays each. Without a significant effort to increase airport capacity, 32 airports will be congested in about 8 years. Congestion at these airports would adversely affect 76 percent of all air passengers, a rather startling prospect considering the ripple effect that congestion and delays at one major airport can cause throughout the system.

This alarming trend can be remedied with new airports and new runways to add system capacity, and with improved technology to take full advantage of existing airport capacity. It is the latter on which the Industry Task Force has focused its attention to identify and recommend technological concepts to increase capacity, and to identify needed research and development funding.

The Administration's Fiscal Year 1989 budget request of $155 million for FAA Research, Engineering & Development is, regrettably, short of the authorized level, and is clearly not enough to do the innovative work which must be done. It is time to recognize that over the past several years the actual R&D in FAA has been starved almost to extinction, and the expert staffing needed to conduct it has dissipated. Much of the funding labelled "R&D" over the past several years has in fact been spent on the engineering design of the NAS Plan systems -- work that is needed and essential because the NAS Plan F&E was underfunded, but not R&D in any real sense. It is probably correct to say that for FY 1988, two-thirds of the R&D appropriation was spent for the design of the NAS Plan systems, and that of this year's request only about half will go towards real research and development.

We are pleased to see that Administrator McArtor is moving to reestablish an effective R&D organization in FAA, but he needs Congress' help to fund it appropriately and to find and hire the bright young engineers and scientists who are essential to its work.

Nowhere is this matter more urgent than in the area of airport capacity R&D and implementation. You may be aware that in 1982, at the urgent request of then-Administrator Helms, an

Industry Task Force on Airport Capacity Improvement and Delay Reduction was formed to offer advice and recommendations to FAA. The Task Force was organized by AOCI and has high-level representatives from virtually all major industry organizations.

To summarize the views of the Industry Task Force: For years since the release of the National Airspace System Plan, which the industry embraced almost totally, we have all known that the Plan does not do justice to the airport capacity problem. The NAS Plan contains very little work on airport capacity, and virtually no F&E funds to actually implement the airport capacity gains that research and development can and will bring.

If, as we believe, the work to achieve reduced spacings on parallel and converging IFR approaches succeeds, for example, the cost for the equipment needed to provide the capabilities at just 42 busy airports will be about $250 million -- a small investment in terms of the benefits expected, but nowhere to be seen in the FAA budget. Specific proposals and recommendations of what must be done have been made by the most reputable industry leaders. Yet, the NAS Plan does not do enough to solve the airport and system capacity problem.

We have attached an analysis of the airport congestion problem (Attachment 1) recently approved by the Industry Task Force, and a list of the essential projects (Attachment 2) we feel need to be pursued vigorously, with both funds and qualified FAA people. Is there really a payoff from this work? We certainly think so. Two examples:

1. For the year 2000, it is estimated by FAA that independent parallel runway Instrument Flight Rule (IFR) operations at nine airports will show annual delay savings of 222,000 hours and a resulting cost savings of $357 million.

2. Similarly, reduced-minimums IFR approaches to converging runways at five airports will yield annual delay savings of 400,000 hours and a resulting annual cost savings of nearly $600 million.

From a broader perspective, we think technology can bring an average capacity gain of 30 percent. When you recognize that every one percent of capacity gain yields about a five percent reduction in the cost of delay, it is a powerful incentive to move forward.

For several years the Task Force has strongly urged a more intensive effort on airport capacity. But for each of those years, including this year, the funding has been inadequate to the need. For fiscal 1987, after a major push by the Industry Task Force, Congress earmarked $5.5 million of the FAA R&D

appropriation specifically for airport capacity R&D projects identified by the Task Force. While a beginning, it was significantly below the amount required and could hardly address the need. Yet, some progress was made through those funds which otherwise would not have been achieved.

The Task Force believes that at least $25 million for R&D alone, plus at least a like amount for F&E support is needed each year for several years to come in order to advance this very important work. The $25 million represents the minimum amount authorized for fiscal years 1988, '89 and '90 in the new Airport and Airway Safety and Capacity Expansion Act of 1987, in which the conference committee directed FAA "to undertake increased research and development activities directed toward technologically advancing the design, construction, safety, maintenance, and operation of airports." We are very grateful to you, Mr. Chairman, and this Committee for recognizing the problem and authorizing the $25 million.

Unfortunately, neither the FY'88 appropriation nor the FAA's FY'89 budget request provide that bare minimum level. In the FY'88 Continuing Resolution, the appropriations conferees expressed concern over the insufficient attention given airport capacity R&D. However, when the demonstrable need was for more than $30 million to make a real impact, the conferees, at the last possible moment, eliminated the funds that had been earmarked and instead directed FAA to tell what it's doing on airport capacity work. Because of lack of funding, the answer is "not much".

What has the Task Force done?

-- We have clearly identified the priority R&D work which must proceed, and the related procedure development and analyses and facility implementation which must be done.

-- We proposed that FAA, clearly understaffed in the experts needed to carry out the work, establish a center-of-expertise, outside the agency, with consistent funding, a realistic schedule for achievement, and a clearly identified and accountable FAA manager for the work. We have offered industry experts to serve as advisors.

-- The Administrator of the FAA has said that we need to raise the issue of airport capacity to the level of a national debate -- we agree. However, the problem in the government is that there is still a lack of a consistent DOT/FAA policy which establishes the importance of the airport and system capacity problem as a real priority. Nor is there a unified organizational structure to make it move.

-- NASA, with a great deal of expertise, and literally

thousands of people dedicated to aviation, has not been utilized enough. We are letting a major national resource go little used.

In responding to the Task Force recommendations and Congressional direction to identify projects related to airport capacity, it is tempting for FAA to include in that category projects which are only peripheral to the achievement of full-time capacity gains:

-- A great deal of FAA's R&D work contributes in one way or another to the achievement of capacity, and it is therefore easy, in constructing and justifying a budget, to include under the heading of airport capacity R&D anything that impacts it, even inferentially.

For example, it can be argued with some justice that work on Controller Human Factors, or the Central Weather Processor, or general System Capacity belong properly under the airport capacity R&D heading. Similarly, work to increase poor-weather system reliability or reduce operating minima in bad weather clearly has an impact on overall airport and system capacity, but probably hides the need for the work the Industry Task Force has identified.

-- Further, in looking at budgeted amounts and the necessarily brief and often vague descriptions, it is difficult to tell how much of the budgeted amount will be used for the Federal payroll and plant, how much for study and analysis, and how much to actually completing the project to achieve new capacity. Only detailed study with the cognizant FAA managers will produce a meaningful assessment.

In selecting the elements of needed effort the Industry Task Force chose to concentrate on tasks which show promise of yielding <u>increases in the direct, intrinsic, maximum achievable capacity</u> of an airport complex. This selection casts no negative reflection on other necessary FAA R&D work, but identifies the tasks which are considered to have the highest payback in terms of direct, full-time airport/terminal area capacity.

For example, a Terminal Doppler Radar is a safety tool which can increase airport operational reliability, and is therefore welcome. However, reduction in lateral or longitudinal spacing requirements, or reduction in required wake vortex spacing, or the ability to provide independent arrival or departure streams, or the ability through automation to reduce inter-arrival variability, would provide a <u>direct capacity increase essentially full time</u>, right at the cutting edge where the requirements are.

We continue to believe that it is appropriate to establish a separate line item for the work on airport capacity R&D and F&E, so it will be clear that the work is receiving the appropriate

priority, and we recommend the definition suggested above for airport capacity work to distinguish these projects from other valid, related activities by FAA.

To make this point even clearer, the Industry Task Force wrote to Administrator McArtor on March 1, asking for his assessment of how much time and how much funding would be needed to bring the Task Force recommended projects to first operational implementation. The response (Attachment 3) is revealing and valuable. Our analysis of the Administrator's response (Attachment 4) shows that far more funding is needed than is being asked for and the funds needed are R&D, F&E and other funds as FAA breaks them down.

It is pertinent that while FAA has recently announced that $24 million would be spent on airport capacity R&D in FY1988 and $40 million in FY'89, only about $16 million and $26 million, respectively, will be allocated to the efforts identified by the Industry Task Force, and no F&E or other funds are identified. The remaining work to make up the $24 million and $40 million, respectively, will be projects which are in many cases worthwhile but are peripheral to the main capacity gainers. Contrast this with the nearly $50 million per year that Administrator McArtor says is needed to move the Task Force recommendations to first operational implementation (and that amount assumes a rather leisurely schedule for some of the initiatives.)

We strongly urge the Committee to maintain vigilant oversight over the FAA's work in this area. We also recommend that FAA be asked to provide details on the F&E and other funding needed to bring the R&D work to operational use at airports which will benefit. After all, R&D without energetic follow-up to implementation yields only dry reports, whereas operational results are needed urgently.

Thank you.

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Attachment 1

INDUSTRY TASK FORCE ON AIRPORT CAPACITY IMPROVEMENT AND DELAY REDUCTION

March 1988

THE AIRPORT CAPACITY AND CONGESTION PROBLEM AND A TECHNICAL APPROACH TO IMPROVEMENT

Introduction and Summary

The purpose of this paper is to provide a perspective on realistic technology remedies for airport capacity limitations, and to suggest strengthening a series of technology R&D initiatives.

Airport capacity limitations and the resulting congestion and delay continue to plague the aviation system at major airports. As traffic grows, the problem gets worse, the cost of delays is formidable, and remedies that constrain demand become ever more compelling. In order to help establish priorities and realistic limits on what may be achieved, a recent study commissioned by FAA* was designed to stand back and assess what may be realistically expected of technology improvements. The results, in a nutshell, are the following:

There are only a few ways to get increased airport capacity to contain congestion and delay:

1. By far the highest payoff comes from new airports and new runways, sited to minimize environmental impact.

2. The second highest payoff comes from safe reduction of separation standards, longitudinally and laterally, in order to permit an airport with a given amount of real estate to yield the highest capacity. Where possible, the segregation of slower, lighter aircraft from faster and heavier aircraft within the airport complex into several separate arrival streams optimized for aircraft weight and speed is clearly valuable.

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* Lebron, J. E. "Estimates of Potential Increases in Airport Capacity Through ATC System Improvements in the Airport and Terminal Areas," The MITRE Corporation, McLean, VA, October 1987. FAA Report DL-5 87-1, MITRE MTR-87W203.

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3. The third is by the reduction of variability (through automation in aircraft and the ATC system) -- highly efficient flow management to best utilize the terminal airspace and airport resource, the reduction of interarrival variability over-the-threshold, and reduction of the variability of runway occupancy time. Essential ingredients are a) better real-time knowledge of winds and wind gradients, b) more accurate knowledge of actual airport and terminal airspace capacity, and c) better communications/coordination between aircraft and the ATC facility.

4. A closely related ingredient is optimization of the use of the airspace in the airport vicinity and beyond, - such as the FAA East Coast Plan, West Coast Plan, and individual airspace aircraft flow analyses for specific airports.

5. The final ingredient is the recognition that terminal airspace, airports, and aircraft capability must be dealt with as an integrated system. Hackneyed as it sounds, improvements in the three elements separately will yield less than the sum of the parts unless there is meaningful integration. The old-fashioned process of dividing enroute ATC and terminal ATC, ATC from airport operations, and aircraft capability from either is counter-productive.

These are the primary ingredients for airport capacity increases and the only ways, beyond constraining demand artificially, to reduce airside congestion. None of the remedies is likely to bring airport capacity under Instrument Meteorological Conditions (IMC) to the capacity routinely achieved in Visual Meteorological Conditions (VMC), yet there is virtue in attempting to increase IMC capacity to approach the equivalent of VMC operations (see below).

There is little here that the knowledgeable analyst hasn't known, but the relative value of the several remedies is revealing. FAA R&D programs are identified for all of these areas, but the pace of completion of these efforts and their implementation has been slow. The National Airspace System (NAS) Plan from the beginning recognized the importance of airport capacity but airport capacity R&D and implementation has for years taken a back seat to other NAS Plan programs. This is no longer so as a result of industry concern, but the pace, intensity and funding of these efforts remains wanting.

Energetic pursuit of current efforts is not enough. There are other things to be done, and new initiatives to be taken, by:

- Expedited introduction of real ATC automation on the ground to match the more advanced level of automation in large aircraft.

- Early introduction of digital air/ground (data link) communications.

- Demonstration and use of Microwave Landing System (MLS) capabilities.

- A prudent new look at ways to have pilots "self-space" their aircraft on final approach in IMC, as they do well in VMC.

- Introduction of cockpit traffic information systems and techniques which will make pilots sufficiently comfortable with the other concepts to gain their enthusiastic support.

A coherent, well-funded FAA R&D program with finite milestones and a dedicated group of experts is essential.

Different Viewpoints

It is useful to examine the views which different elements of aviation hold about the system in which we operate together.

Airspace Users - Airlines, business, and general aviation often see the air traffic control system as a necessary evil and a constraint on their ability to do what they wish to do. They view the mass of procedures and rules and regulations as a costly limitation on their freedom. They see delays at sector boundaries, routing limitations, and imposed departure delays, flow restrictions and quota rules as a series of red lights which a more "efficient" FAA could turn green. Airlines have responded to business opportunity and have increased the demand on the airports through more flights, hubbing, and other business mechanisms. They rail against the fundamental reality that airport and terminal area capacity is limited and that increasing demand on stressed resources spawns delay. Yet the mechanism by which delay cost increases asymptotically as the actual capacity of an airport is approached has been known and understood for years.

Pilots and pilot groups often agree with this assessment but view the remedies differently. To pilots in command who are charged with ultimate responsibility for the safety of their passengers and aircraft, attempts to improve the system by making new demands on their operations, or reducing separation standards, are properly viewed with a jaundiced eye, lest safety be somehow compromised. ATC automation is sometimes seen to erode the authority and prerogative of the aircraft commander, while taking from him at least part of his ability to assess the total situation and to assure that automation is working properly. An historic concern is the possibility that the introduction of digital communications, a vital ingredient in automation, may remove the "party line" which permits the pilot to appreciate, at least in part, what the air traffic control system is doing.

Airport operators, the narrow end of the airspace funnel, are motivated to increase the capacity of airports through changes within their purview, - such as addition of runways and taxiways,

added gates and passenger facilities, and optimized airport surface movement. Increased capacity and aircraft movement efficiency is of primary and direct interest to airport operators in making their airports attractive limited primarily by the need to maintain safe and environmentally sound operations. Their enthusiasm for additional traffic must be tempered by concerns about the impact of noise on airport neighbors, and they support all reasonable means to mitigate noise impact through quieter aircraft, use of least-noise paths and noise abatement procedures.

FAA, charged with managing the air traffic control system and assuring safety for everybody, sees the rules and procedures as essential tools in making a very difficult job manageable. The same flow restrictions or quota rules which operators see as restrictive red lights are viewed by FAA as essential to provide the highest level of safety and efficiency for everybody without imposing burdens on individual controllers which they cannot handle safely. The system modernization of the NAS Plan, a continued program of financial aid to airports, the continuing analyses and restructuring of busy areas to assure that the procedures in use provide the best achievable results, will improve the situation, but will not satisfy the demands of increasing traffic. (FAA recognizes the importance of R&D and technological change, but has not acted decisively to achieve R&D output and results.)

The problem is that all the viewpoints are legitimate. Let's look at what can be done.

Background

Literally libraries of papers, analyses, operational research, and reports of development have illuminated the airport congestion problem. Experts of the FAA, the National Aeronautics and Space Administration (NASA), and many industry and academic groups have been at work for years. Industry experts, singly and in groups, have studied the problem and offered recommendations on which extensive developments and research have been based. Yet the problem remains and is getting more serious. Although airport capacity is higher now than it was a few years ago, the gains have been inadequate as the demand for utilization of the Nation's airports has grown rapidly.

Technical solutions which would create major increases in capacity have been elusive. Some developments which seemed promising either failed to find acceptance or were overtaken by events. (The FAA's development of an automated terminal metering and spacing systems on which large resources were expended a decade ago failed to find acceptance for a variety of reasons, in part because requirements changed between conception and implementation, and because the approach was technically too ambitious and operationally not ambitious enough. The Wake Vortex Advisory System, which was taken to a late stage of development was found unacceptable to important segments of the pilot and controller community.)

Recent activities to safely reduce separation standards in the lateral and longitudinal dimensions so as to exploit the capabilities of parallel runways, converging runways, and short runways -- work that grew out of the findings of a series of FAA/industry airport task forces charged (as early as 1975) with finding realistic ways to increase capacity -- have progressed, albeit slowly, with continued serious reservations expressed by some.

Major improvements in the management of aircraft flows have been implemented by FAA and are distributing unavoidable delays more fairly throughout the system rather than concentrating them at the busiest airports. Flow control, an absolutely essential tool after the 1981 controller strike, has evolved into a means to manage limited airspace and airport resources. But it is far from perfect. It is seen by some as artificial constraint of aircraft movement because it is not perfect, and cannot be perfect as long as the fluid in which aircraft fly is not perfectly defined or predictable into the future, and as long as the actual airport capacity at the destination is not absolute and unchanging. Airlines are clamoring to overcome these limitations by reinstituting terminal area holding in order to be able to fill up unused airport slots when the best predictions of actual capacity are found to be conservative. Flow management is not a means to achieve intrinsically higher capacity; it is a way to use existing airspace and airport resources as efficiently as possible.

Some remedies for airport congestion have been found unacceptable to man. Eliminating the slower general aviation and business aircraft from major airports during busy hours, or restricting takeoffs and/or landings to heavies or lights or mediums for given amounts of time would yield higher overall capacity, but would violate the 'first come, first served' principle and could establish an autocratic rule over the utilization of particular airports. Giving priority to aircraft that can achieve over-the-threshold target time to within 3 to 4 seconds instead of the current mean of about 18 seconds has seemed equally unacceptable; as has the idea of normalizing or standardizing runway occupancy time which has a variability of 12 to 16 seconds and limits the top runway capacity.

What Can Be Done?

Are we on the wrong track, when promising developments have failed to find acceptance? When even the good ideas, if implemented, will each yield only small capacity increases? When the path from investment in new technology to implementation and benefit-reaping is not clear or agreed ahead of time?

Let's look at things that can be done and see if there are ways to overcome the objections which have prevented the implementation of even some of the small capacity gains which seem achievable:

1. More airports and more runways and the flexibility to use them efficiently.

In the hierarchy of capacity gains, more runways and more airports clearly top the list. This discussion will not deal with the political, financial, and environmental problems involved in creating new airports and new runways, but there are one or two things to be said. In the broad sense, the achievement of new runways is made easier, particularly at existing airports with limited real estate, by achieving safe reductions in the minimum spacing requirements between runways that permit independent IFR operations, enhancement of the capability to use separate arrival and departure paths for different classes of aircraft, by using flexible approaches and departures, and by preventing interference between approaches to different airports in the same vicinity.

The large and increasing speed disparity between aircraft types wishing to use major airports suggests terminal ATC system designs which segregate heavier, higher approach speed aircraft from lighter, slower, less wake-producing aircraft; and flexibility in establishing approach and departure paths to help avoid noise sensitive areas and thereby make increased traffic acceptable to the surrounding community. The key is the ability for aircraft to navigate precisely on flexible approach and departure paths, along with a high-accuracy surveillance system. The ingredients are the long-promised/and long-delayed Microwave Landing System (MLS) and the modern Mode S surveillance system and its data link.

2. Reduction in minimum separation requirements.

High on the list of capacity gains are those achievable if IFR separation standards can be reduced safely. Over the past several years, and as a result of extensive studies of individual airports, FAA has concentrated on achieving closely-spaced parallel IFR operations, achieving lower IFR minimums on converging approaches, reducing the longitudinal interarrival spacing requirements, exploiting separate arrival/departure paths for short runways, achieving multiple glide slope angles for wake vortex avoidance on parallel IFR approaches, the concept of "almost-parallel" splayed or curved approaches to parallel runways, and attacking the wake vortex problem. There have been successes in the reduction of spacing requirements for dependent IFR operations to parallel runways, in the reduction of minima to converging runways, and reducing the interarrival separation, under carefully controlled conditions, from 3 to 2-1/2 nmi.

But successes have come slowly and the gains have been small relative to the need. There are many reasons. Perhaps the most important one is the reluctance, especially of pilot groups, to agree to reduce separations from levels which have proven safe in practice.

Traditional separation standards usually have been arrived at judgmentally, i.e., without attempts at elaborate mathematical risk assessments. Yet assertions that new separation reductions are safe

must be based on analysis -- often mathematical analysis with inherent and often unprovable assumptions. Perhaps greatest is the concern about how to deal with rare events and large errors and their consequences, where analysis must always give way to judgment, and the concern of pilots that a fallible human controller dealing with a complex problem must be depended upon absolutely to prevent disaster.

The problem is compounded by the fact that there is no statistically sufficient data base on how aircraft actually behave during final approach and departure operations, and particularly during missed-approach procedures, for which valid, real life data is sparse, but where the perceived risk is greatest.

In the minds of many pilots, the introduction of automation and automatic detection schemes into this process does not alleviate the concern, in part because automation is perceived to involve computer-to-computer digital data exchange, communications which threaten to remove the "personal" element -- the party line -- on which many pilots depend to maintain involvement and a personal error check on what the ATC system is doing for, or to, them. Pilots believe, rightly, that they must be kept involved in the ATC process so that they can continue to be a part of the error-catching process.

Recognizing that automation and digital data exchange are prospectively important ingredients in achieving better utilization of airport resources, it may be time to look again at some old ideas of relieving the perceived problem, that is, providing the pilot with symbolic information on the status of aircraft of concern around him. The TCAS alert display, now nearing the end of its development, shows again that a display of traffic of concern is feasible. It is prospectively a powerful tool in providing confidence to the pilot that an increasingly complex traffic control process is working properly, while not infringing on the pilot's ultimate responsibility for the safety of the aircraft and passengers.
Several approaches to such a display of traffic of concern are possible, starting with the display of TCAS information.

The recent FAA NPRM on carriage of TCAS pending Congressional legislation make it almost certain that TCAS will be coming to airline cockpits. This will not occur without great expense to the airlines; the NPRM estimates that implementation will cost the industry $748 million, but many feel that the unquantifiable protection afforded by TCAS makes it worth the price.

TCAS can provide, for the first time, traffic information in the cockpit. There may be ways in which the cost of TCAS can be offset by capacity increases and ATC efficiencies by applying the TCAS information in an environment of cooperative ATC.

Alternatives are transmission of data on traffic of concern to the aircraft from the ATC surveillance system, or display of information from other aircraft which would frequently broadcast their own position, and perhaps heading and intent in the manner of a "blinking beacon" suggested years ago by Lincoln Laboratory and others.

High-quality, high-accuracy position information would be required. All the classic problems of avionics costs, the need for universal equipage, and a multiplicity of other problems which have killed the idea in the past still affect consideration of this concept, but it is time to move out. The cockpit traffic information display and cooperative ATC system could be used at all airports without the need for specialized ground equipment, and there is a possible reduction in controller workload.

3. Reduction of variability through automation.

It is sometimes asserted that the best way to achieve optimum utilization of the airport resource is full automation of aircraft operations near and on airports. In the extreme, an all-knowing computer on the ground would take hold of the aircraft and "fly" it automatically through touchdown and rollout to turnoff in accordance with a marshalling and sequencing scheme based on full knowledge of the actual terminal area and airport capacity, the winds and shear conditions aloft and by automatic dispatch of departures. Assume for a moment that this Utopian notion makes sense, that it might somehow be acceptable to transfer operation of an aircraft from the cockpit to a ground computer, that it is feasible for a ground computer to acquire enough information on aircraft condition and energy state to make such control sensible, and that dozens of other conditions could be met.

The recent analysis* conducted for FAA shows that, even in this dream scenario, IFR capacity gains are not overwhelming -- perhaps on the order of 25 percent or less. If it is now assumed that such a system would not be perfect -- that is, it would not reduce the over-threshold variability to zero, its knowledge of winds aloft would not be perfect, uncertainties of on-runway performance could not be reduced to zero -- realistically achievable capacity gains go to the order of 12-16 percent. That's well worth trying for, but not overwhelming in light of the costs and the problems to be overcome. Such an automatic process, however, if not carefully applied, could eventually reduce the chance to apply the skills and intelligent innovation which human beings use so well to optimize traffic flow into and out of the airports.

With the sobering conclusion that full automation isn't the answer to the maiden's prayer either, what is the proper direction to pursue in taking advantage of automation of the terminal area air traffic control process?

While automation, both in the aircraft and in the air traffic control system, would appear to be a valuable prescription for reduction of the variabilities, pilots and controllers working as a team using

their best collective judgment are likely to produce higher achieved capacity than "full automation" of the air traffic control system. In other words, until and unless automation is as intelligent and as innovative as the best pilot/controller teams have repeatedly proven themselves to be, automation must be approached carefully lest it prove to be an expensive white elephant.

This is not a jab on automation, but a view that automation, especially at and near the airport, should be used to enhance the innovative intelligence that only human pilots and controllers can provide. It says something about the automation to pursue -- automation which can enhance rather than replace the innovation and judgment that human beings bring to the control job.

Several things seem right. Perhaps most important, and seemingly achievable, is automation of the process of marshalling and sequencing aircraft in an optimal fashion in the transition area, working hand-in-hand with the Traffic Management System (TMS) from perhaps 150-200 miles away from the airport. The ingredients, as before, are high-quality information on aircraft position and aircraft capability, the best possible information on winds aloft, and information on the actual current and near-term projected capacity of the airport. A major ingredient is knowledge and utilization of aircraft capability to make good particular waypoints and arrival times. That process becomes simpler as more aircraft become equipped with 4D area navigation equipment and flight management systems, permitting sound assumptions to be made as to aircraft ability to make good a described path and time. Recognizing that approach winds will not be perfectly known, full advantage can be (and is now) taken of the capability in many aircraft to determine instantaneous winds from inertial reference systems and flight management systems. Digital information exchange and digital communications are essential ingredients in achieving the highest efficiency of such a sequencing and marshalling system -- perhaps again pointing up the desirability of a traffic display to make pilots comfortable about the workings of such an automated system.

As aircraft near the airport, innovation and ingenuity of pilots and controllers should be used to achieve the highest airport capacity by use of self-spacing where that is appropriate, and by letting the human controller do what he does best in assessing a now limited-variable situation and applying innovative solutions in real time. This process can be aided by automation of a somewhat different type, characterized by the work done in "expert systems", such as the "controller associate" research by MIT, University of California Berkeley, Carnegie-Mellon and others in which computers would offer the controller useful information and options in an advisory (i.e., non-threatening) manner, offering turn-to-final advice, among other things. Systems like DICE, the German COMPAS, or the NASA efforts may be forerunners of such capability. Both controllers and pilots would be involved fully in this final approach process, using their combined capabilities.

The automation effort should be devised in recognition of three fundamental requirements: a) that automation be introduced and used where it can actually do the job better than human controllers and pilots working as a team; b) that automation aids should be used to best utilize the controller and pilot/aircraft capabilities; and c) recognition that automation and optimum efficiency of the system will require major improvements in information flow and exchange, that such information flow will have to be largely digital in character, and that a way must be found to provide cockpit information on traffic of concern and its intentions.

4. Bringing IFR Capacity Closer to the Level of VFR Capacity.

It is well understood that airport capacity in VMC is significantly higher than under IMC, and it is conceded that reductions in separation standards and the reduction of variability through automation will, in all likelihood, not produce a level of capacity equivalent to that achieved under VMC, when pilots themselves are visually aware of other aircraft of concern and are responsible for spacing themselves and for their own wake turbulence protection. The reason, simply put: pilots are more willing to accept reduced separations when they can see and appreciate other traffic with their own eyes and can exercise their own judgment.

Equally important, in IMC even the best controller team is limited by the lags involved in communications and surveillance, and the delays introduced by the times required for perception and initiation of corrective action when there is more than one person in the loop. This effect was studied by Swedish of the MITRE Corporation in work for FAA published in August 1979.** Once again, a prospective help may be a reconsideration of work done years ago on "electronic VFR," which involved providing accurate position information on aircraft of concern to the pilot by means of a cockpit display of traffic.

While cockpit traffic displays have a variety of problems and are subject to misuse, they have a unique capability in the maintenance of longitudinal spacing. The possibility for pilots to "self-space" on the final approach would permit elimination, or at least reduction, of the "lag loops" mentioned above. The ingredients would be very high-quality position information both of the pilot's own aircraft and on the aircraft ahead, preferably all the way down to an on the runway to the turn-off point, along with an easy-to-assess display not only of the aircraft ahead, but also of other aircraft of concern approaching or departing the airport. It is doubtful whether the full VMC capacity could ever be achieved, but it may be worth exploring again how close one could come and to examine again the cockpit information requirements to approach VMC capacity in this shared-responsibility arrangement in IMC.

** Swedish, W.J. "Evaluation of the Potential For Reduced Longitudinal Spacing on Final Approach," MTR-79W280 (FAA-EM-79-7), The MITRE Corporation, McLean, VA, August 1979.

5. Better Knowledge of Winds and Wind Gradients.

A variety of studies have shown that even small variations of winds along the approach have a significant impact on interarrival time variation. Lack of accurate real-time and projected knowledge of winds aloft complicates the flow management process and makes it considerably less than perfect. Coupled with the safety requirements for protection of aircraft from wind shear and the effects of microbursts, better real-time and projected knowledge of winds and wind gradients is essential to the optimum performance of the en route and terminal flow management system and efficiency in the use of existing airport capacity resources.

6. Improved airport surface surveillance, guidance, and control.

While there have been dozens of analyses, studies, and developments of surface surveillance systems, and some excursions into rudimentary surface guidance and control systems, no such systems have come close to implementation other than simple, primary airport surface detection radar. Yet, as capacity increases and airports become more complex, as they inevitably will, more efficient surface traffic control becomes highly desirable. Control, and perhaps reduction, of runway occupancy time is an important ingredient in making best use of the runway resource since interarrival separations are heavily impacted by the length of time aircraft stay on the runway, and improved aircraft energy management during the rollout and in preparation for turnoff requires high-quality information on progress along the runway.

Guidance to and during the turnoff would seem to be of value to encourage use of "high speed" exits and automation of traffic control on the airport itself should be far more readily achievable and acceptable than the more difficult three-dimensional automation required in the air. Better control of runway incursions awaits not only better airport surveillance, but also improved presentation and an automated level of guidance and control of aircraft movements on the surface.

Once again, the essential ingredient is adequate surveillance and guidance information on the airport itself, preferably using the same or similar surveillance and guidance systems used in the airspace, and preferably of a kind in which the information can be transmitted to the cockpit for some of the uses described above.

The Bottom Line: Development Direction

Where does all this lead? There are still no miracles, nothing we can do will double or triple the capacity of our airports, nor can anyone, by magic, pour a quart into a pint jug. The above assessment seems to say that a number of the development directions FAA has been mostly talking about are right and need to be pressed energetically. But more can be done. Automation is valuable, but limited; automation of the marshalling and sequencing process, tied closely to the flow management system, is the most promising real automation, but work on (expert) systems which give the controller better tools to use his own innovation and ingenuity close to the airport is worth

pursuing energetically. There may be ways to overcome the reluctance of pilots to accept safe separation reductions, and to become more involved in the terminal air traffic control process rather than less, by provision of higher accuracy position data and better and more comprehensible information in the cockpit.

If this assessment makes sense, it calls for increased application of resources -- dollars and experts -- to present efforts, as well as to several new initiatives and to rejuvination of old ideas previously discarded or unexploited.

A Comprehensive, Coherent R&D Program

Beyond doing everything that can be done to achieve more airports and more runways, the major elements of a closely integrated effort should be as follows (work is underway on some of these, but at a very slow pace):

- Early Completion of Work on Current Capacity Improvement Concepts

  Continuation and expedition of the now-traditional capacity improvement concepts long under study and development: closely spaced parallel IFR operations, reduction of IFR minimums on dependent and independent converging runways, reduction of longitudinal separation, exploitation of short runways, exploitation of almost parallel splayed or curved approach path operations, etc.

- Near-and-On-Airport Aircraft Performance Data

  Conduct of a data gathering effort to obtain valid, up-to-date information on actual aircraft performance in the terminal area on final approach and, most importantly, during missed-approach operations to help in establishing better and more realistic risk assessments.

- Utilization of the Microwave Landing System

  Expedited development of procedures for use of the microwave landing system to permit achievement of improved terminal capacity, reduce operating minima, and achieve least-noise arrival and departure paths.

  Implementation of the Microwave Landing System to establish acceptable arrival and departure paths to major airports for heavy, fast wake-producing aircarft separate from light, lower approach speed aircraft to create reduced noise-impact profiles, to achieve the use of multiple glide slope angles for wake vortex avoidance on parallel approaches to utilize fully the MLS capability to provide other than straight-in 3 degree approaches to parallels and to provide precision departure and missed approach guidance, and a variety of other procedures.

- Terminal Automation

  Development, at the earliest possible time, of an automated marshalling and sequencing system tied closely to the TMS flow management system, and extension of the capabilities of the Runway Configuration Management System to improve on the determination of current and near-term projected actual airport capacity.

  "Time-to-turn to final" advisory systems, and subsequently their enhancement by 'expert system' assistance to controllers should be energetically pursued for the final portions of the approach, and the optimum combination found to utilize aircraft capabilities, controller ingenuity, and automation help to achieve best use of the airport resource.

- Better Knowledge of Winds and Wind Gradients

  Because accurate knowledge of winds aloft and discontinuities in the airspace environment have a major impact on airport capacity, and since any marshalling and sequencing system and optimal usage of the airport resource depends heavily on knowledge of winds on approach and departure, current efforts to implement terminal weather radars which have the capability of providing accurate wind and weather data en route and at terminals should be pursued. That information should complement, not substitute for, the use of accurate wind information available in aircraft which are equipped with inertial reference systems and sophisticated flight management systems.

- Coping with Wake Turbulence Effects

  A new wake vortex data gathering effort should be undertaken as an input to development of an automation program to transition from the simple 3,4,5,6 mile wake vortex spacing to one more capable of using actual aircraft wake signatures to eliminate unneeded wake vortex restrictions, but simple enough to be acceptable to controllers. At the same time, the early work on the Wake Vortex Advisory System should be reopened to determine whether acceptable actual wake vortex sensing and related procedures can be found to further ameliorate the wake vortex restrictions.

- Cockpit Traffic Information

  Using the earlier work on cockpit traffic information displays, augmented by more recent work on the TCAS alert displays, a development and demonstration effort should be undertaken to provide information in the cockpit on aircraft of concern and to once again establish the possibilities and limitations of "electronic VFR" to permit pilot self-spacing on final approach to reduce the impact of the lag loops imposed by the present control process.

The development and demonstration effort should establish the possibilities and limitations of a cooperative ATC system in which the pilots

a) would be able to refine spacing on final approach to reduce the impact of lag loops imposed by the present control process;

b) would be able to use TCAS to derive information to replace the party line dialog lost in a data link communications environment; and

c) would utilize traffic information to gain confidence in highly automated ATC processes.

- Airport Surface Surveillance, Guidance, Control, and Automation

Development should be undertaken, based on earlier analysis and development of surface surveillance, guidance, and control systems, and using the ASDE radar as the takeoff point, of a modern surface surveillance guidance and control system to provide, in several stages of automation, a full airport surface surveillance system. Its guidance function should provide information to aircraft on such aspects of runway remaining, turnoff, and taxi operations. It should provide for better protection against runway incursions and should be the basis for automation of surface traffic movement. To the extent possible, the surveillance elements, as well as the guidance and control elements of such a system, should be technically compatible and interoperable with the terminal area airspace surveillance and communications systems to minimize avionics requirements as well as air traffic control equipment. The digital data link information exchange and communications needs should be a part of the larger digital communications system for air traffic control.

- More Accurate Surveillance Data for Pilots and Controllers

Recognizing the future need for very high accuracy position information, both for the near airport air traffic control surveillance system and for pilot displays of traffic which may be in near proximity, analysis should be undertaken to establish the minimum requirements for accuracy and integrity for such an on- and near-airport surveillance system, and to establish a rational transition to such a new capability. Candidate technologies should be the Mode S surveillance system and its data link, and logical evolutions from it, through use of multilateration and other techniques; other, perhaps unique, terminal area surveillance systems; the potential of an integrated surveillance and navigation guidance system; the possibility for use of high-accuracy satellite navigation (as described by the ICAO Future Air Navigation Systems Committee), perhaps differentially augmented on a local basis; the concept of an automatic dependent surveillance scheme; and a reexamination

of the potential of the "blinking beacon" idea which might automatically and frequently transmit accurate aircraft position, as well as heading and potentially other information, to all other aircraft of concern, as well as to the ground ATC facility.

This kind of surveillance/guidance system for high-density terminal area operations should be able to encompass both the terminal airspace and the airport surface and should be suitable as a source of high-accuracy aircraft position information which might be usable both on the ground and in the aircraft as a basis for collision avoidance in the long term. The digital communications requirements and traffic loads for use of such a system for its various purposes needs to be included in the analysis.

A cohesive airport capacity research and development program with a critical mass of experts and money, with early milestones and output, containing these elements as a coordinated effort, and taking full advantage of earlier work, would help to achieve the highest capacity practically achievable from our airport system.

Attachment 2

AIRPORT CAPACITY TECHNOLOGY AND PROCEDURE DEVELOPMENT NEEDS

Rather than describing needed airport capacity efforts in terms only of R&D required, the following describes the need in terms of the results needed, since all of the work requires not only R&D but also implementation, procedure development, safety studies, and training.

INDUSTRY TASK FORCE OBJECTIVES

1. Reduce required IFR spacing between parallel runways to 3000'

2. Reduce minimums for IFR operations to converging runways to near VFR minimums

3. Establish procedures for IFR operations to triple runway operations

4. Introduce automation aids for controllers into terminal area operations to

   a. achieve optimal arrival sequencing

   b. provide guidance for staggered arrivals

   c. achieve minimum required wake vortex spacings

   d. reduce inter-arrival variability by 50%

5. Develop requirements and procedures for use of cockpit traffic displays to provide better information to pilots on traffic situation, and permit pilot participation in approaching VFR capacity in IFR conditions

6. Complete development/refinement of airspace and terminal area traffic flow analysis models, and apply as appropriate

7. Gather actual current aircraft performance data near and on airports and during missed approach operations to permit use of realistic data in separation reduction studies (Use data from efforts 1&2 as appropriate)

8. Renew efforts to reduce operational impact of wake vortex

   a. by developing refined aircraft classifications

   b. by developing automated tools to permit controllers to apply minimum required spacing routinely

c. by completing development of previously abandoned wake vortex detection and advisory system

9. Expedite development of procedures for beneficial MLS application

   a. by reducing operating minima commensurate with MLS capability

   b. by rapid completion of MLS Cat.2/3 facilities

   c. by rapid development of procedures for MLS capacity enhancement, and development of least-noise arrival and departure paths

10. Continue and expedite specific-airport capacity improvement studies, and apply new technology concepts to establish their local application

11. Improve safe on-airport air traffic movement and control

   a. by improving airport lighting and marking to provide for safer airport operations during runway entry and turnoff, departure and crossing, reduction of runway occupancy time

   b. by development of automated, airspace system-compatible airport surface surveillance, guidance and control system which supports improved runway incursion control

12. Continue pavement design R&D to establish standard runway design criteria, improve pavement longevity, reduce impact of runway construction on airport operations, and obtain best value for AIP investment

13. Complete work to establish better data on runway friction and its operational relation to runway occupancy time

Attachment 3

U.S. Department of Transportation
Federal Aviation Administration

Office of the Administrator

800 Independence Ave. S.W.
Washington, D.C. 20591

APR 21 1988

Mr. J. Donald Reilly
Chairman, Industry Task Force on Airport
Capacity Improvement and Delay Reduction
1220 19th Street, NW.
Washington, DC 20036

Dear Don:

I apologize for not responding more rapidly to your letter of March 1 concerning airport capacity program project objectives. The importance I place in this area required that the response be widely coordinated and that process had to compete with preparing for the 1989 congressional appropriations hearings.

Enclosed are the Federal Aviation Administration's (FAA) estimates of the total funding and time required for first operational implementation, as well as a funding breakdown for each of twelve objectives. My staff has taken the liberty of relating the objectives to planned projects appearing in the FAA's Airport Capacity Enhancement Plan and/or the Research, Engineering and Development Plan.

Sincerely,

T. Allan McArtor
Administrator

Enclosures

RESPONSE TO ITF QUESTIONS, MARCH 1, 1988

QUESTIONS/NOTES \ ITF ITEM	Parallels 1	Converging 2	Triples 3	Staggers 4b	Terminal Automation 4a/c/d & 8b
TOTAL FUNDS 1st Implementation	$25M	$25M	$0.5M	$5M	$80M
TIME REQUIRED to 1st Implementation	5 Years	5 Years	1 Year	2 Years	8 Years
R&D/F&E/OTHER	15%/80%/5%	10%/85%/5%	90%/0/10%	80%/20%/?	90%/10%/?
NOTES	12 Airports ($80M) New radars & displays, comm. equip., procedures	Independent ops @ 30 airports ($170M)	1 airport simulation procedures development	Boston Logan as test/ops site	
RELATED ON-GOING PROJECTS Airport Capacity Enhancement Plan and/or RE&D Plan	-Indep. Parallel IFR Approaches -Parallel/Converging Runway Monitor (PCRM)	-IFR Approaches to Converging Runways -Flight Deck Displays	-Triple IFR Approaches	-Dep IFR Approaches to Converging Runways -Dep. Parallel IFR Approaches -Terminal Air Traffic Control Automation (TATCA)	-Wake Vortex Avoidance Forecasting -Advanced Traffic Management System -Terminal ATC Automation -IFR Approaches with 2.5-nmi in-trail separation -Terminal Radar Enhancements -Terminal Air Traffic Control Automation (TATCA)

RESPONSE TO ITF QUESTIONS, MARCH 1, 1988

QUESTIONS/NOTES \ ITF ITEM	Flight Deck 5	Models 6	Data 7	Aircraft Classification 8a	EVAS 8c	MLS Procedures 9 a,c
TOTAL FUNDS 1st Implementation	$3M	$20M	$1M/Yr	$2M	$4M	$4M/year
TIME REQUIRED to 1st Implementation	5 years	5 Years	1 Year	3 Years	3 Years	4 Years
R&D/F&E/OTHER	95%/5%/?	5%/10%/85%	5%/10%/85%	100%/0/?	90%/10%/?	100%/?/?
NOTES	Joint Program NASA	SIMMOD: Ongoing, 1st operational use was in FY-86, $2M/Yr	Data Collection using new sensor at Memphis/ Raleigh-Durham	Classify New A/C	Enhanced VAS at ORD, Mode S Air-to-Ground link (TCAS)	MLS Demonstration Plan Update
RELATED ON-GOING PROJECTS Airport Capacity Enhancement Plan and/or RE&D Plan	Flight Deck Displays of Terminal Area ATC Situational Information -MLS -ILS/DME	-Airport Capacity and Delay Models -HASPAC	-Independent Parallels -Parallel/Converging Runway Monitor (PCRM)	-Wake Vortex	-Wake Vortex -TCAS -Mode S Data Link	-MLS

RESPONSE TO ITF QUESTIONS, MARCH 1, 1988

QUESTIONS/NOTES \ ITF ITEM	MLS CAT 2/3 9b	Task Forces 10	Surface Traffic 11a	Surface Traffic 11b	Airport Design 12	Runway 13
TOTAL FUNDS 1st Implementation	$30M	$1M/Yr	$4M	$25M	1.5M/Yr	$11.0M
TIME REQUIRED to 1st Implementation	6 years	10 years	5 years	6 years		6 Years
R&D/F&E/OTHER	0/10%/?	1%/1%/98%	a: 100%/?/?	90%/10%/?	100%/?/?	90%/10%/?
NOTES	Initial limited production run of 20 units ($60M)	5 airports per year	Lighting and Marking		Ongoing Activity	Friction Ongoing Activity
RELATED ON-GOING PROJECTS Airport Capacity Enhancement Plan and/or RE&D Plan	MLS	-Airport Capacity Enhancement Task Forces	-Enhanced All-Weather Ground Operations Capability -Airport Surface Detection Equipment (ASDE-3)	-Airport Surface Traffic Automation (ASTA)	-Airport Pavement Model	-Runway Friction Monitor -Runway Occupancy Time (ROT) Advisory System

Attachment 4

April 27, 1988

New Data on Airport Capacity Funding Needs and Funding Plans

The Industry Task Force on Airport Capacity Enhancement and Delay Reduction on March 1, 1988 (Attachment 6) asked FAA Administrator McArtor to provide an estimate of the total funding and time required to bring the specific Industry Task Force airport capacity project recommendations to first operational implementation.

The Administrator responded by letter on April 21, 1988 (Attachment 7)

In summary, the response, based on an AOCI staff analysis, says the following:

The total funding required to bring the projects to first operational implementation	$276.5 million
The time required ranges from 1 to 8 years for specific projects, with two projects continuing The average time for all projects	5 years
If the funding required is spread evenly over the years estimated for each project, total required per year is	$49.2 million
If the funding required is spread over the five year average time, the funding required per year	$55.3 million
If the projects could be speeded up (and some seem excessively long) to an average 3 years, the funding required per year would be	$9[illegible].2 million

The FAA response breaks down the estimates into the funding required for R&D, F&E, and Other Costs. The following is that breakdown, divided into two elements, R&D and Other:

Funding requirement to bring the projects to first operational implementation	R&D $159.8m	Other $116.9m
Funding requirement per year using the estimated times	R&D $27.1m	Other $22.1m

Funding requirement per year using a five year average time	R&D $31.9m Other $23.4m
Funding requirement per year if an expedited three year average time were used	R&D $53.3m Other $39m

The FAA response notes the F&E costs estimated for 12 independent parallel runway systems at $80 million, for 30 converging runway systems at $170 million, and for 20 Cat. 2-3 MLS systems at $60 million, for a total additional F&E cost of $310 million for only these three efforts.

The FAA Administrator has stated that R&D funds dedicated to airport capacity efforts for FY-'88 are about $26 million, and for FY-'89 are planned for $40 million. However these amounts include a series of efforts, many of them important and valuable, which however do not provide additional intrinsic airport capacity as the Industry Task Force has defined it.

Such useful, related efforts include Airport Safety Support systems, Vertical separation reduction efforts above FL-290, NASPAC, Terminal/Landside Modelling, Advanced Traffic Management System, Heliport Design and Planning, Low-Altitude Surveillance, among others. Some of these add capacity or valuable reliability in some circumstances, but are peripheral to the Task Force recommendations.

A generous estimate of the funds actually planned by FAA for the projects identified by the Industry Task Force is as follows:

For FY-'88 $16.7 million R&D, essentially no F&E
For FY-'89 $26.4 million R&D, essentially no F&E

Several of the Industry Task Force recommendations are funded way below the amounts FAA management thinks are needed (Example: Terminal Automation at about one quarter the need for FY-'88, at about half the need for FY-'89; no funding seems to be assigned to studies of use of cockpit display applications)

Bottom Line:

1. The FAA Administator has given us highly valuable estimates of what it will take to bring the Industry Task Force recommendations to first operational implementation

2. While the Industry Task Force and many others have for some years concentrated on the needed R&D funding (and the Congress has authorized $25 million/year for R&D), the Administrator has now made clear that what counts in the end, - achieving first operational use of the

concepts proven safe and successful, - requires both R&D and other funding (F&E and other).

3. He advises that to bring the recommended projects to fruition will require $49.2 million/year for several years.

4. Several of the most important projects are projected to take up to eight years, probably because the priority is not high enough and the FAA expert staffing is inadequate. (The Industry Task Force has recommended that FAA establish an independent, outside center-of-expertise)

5. If a 5-year average completion cycle were assumed, $55.3 million per year would be needed. To expedite to three years would require $92.2 million per year.

6. To implement three of these concepts at a relatively small number of locations, will require at least $310 million F&E.

7. By contrast, FAA plans to spend approx. $16.7 million total for FY-'88, and plans to spend $26.4 million in FY-89, with no corresponding F&E identified.